National Library of Canada
Acquisitions and Bibliographic Services Branch
395 Wellington Street
Ottawa, Ontario
K1A 0N4

Bibliothèque nationale du Canada
Direction des acquisitions et des services bibliographiques
395, rue Wellington
Ottawa (Ontario)
K1A 0N4

Your file Votre référence

Our file Notre référence

NOTICE

The quality of this microform is heavily dependent upon the quality of the original thesis submitted for microfilming. Every effort has been made to ensure the highest quality of reproduction possible.

If pages are missing, contact the university which granted the degree.

Some pages may have indistinct print especially if the original pages were typed with a poor typewriter ribbon or if the university sent us an inferior photocopy.

Reproduction in full or in part of this microform is governed by the Canadian Copyright Act, R.S.C. 1970, c. C-30, and subsequent amendments.

AVIS

La qualité de cette microforme dépend grandement de la qualité de la thèse soumise au microfilmage. Nous avons tout fait pour assurer une qualité supérieure de reproduction.

S'il manque des pages, veuillez communiquer avec l'université qui a conféré le grade.

La qualité d'impression de certaines pages peut laisser à désirer, surtout si les pages originales ont été dactylographiées à l'aide d'un ruban usé ou si l'université nous a fait parvenir une photocopie de qualité inférieure.

La reproduction, même partielle, de cette microforme est soumise à la Loi canadienne sur le droit d'auteur, SRC 1970, c. C-30, et ses amendements subséquents.

Canada

UNIVERSITY OF ALBERTA

"TIPS"
FOR
SUCCESSFUL IMPLEMENTATION
OF
TECHNOLOGY

PRESENTED AS A
TECHNOLOGY TRANSFER ISSUE
FROM THE PERSPECTIVE OF THE
ROAD TRANSPORTATION INDUSTRY

BY

Ray M. Filipiak

A thesis submitted to the Faculty of Graduate Studies and Research in partial fulfilment of the requirements for the degree of Master Of Science.

IN

Engineering Management

DEPARTMENT OF Mechanical Engineering

EDMONTON, ALBERTA

Spring, 1994

National Library
of Canada

Acquisitions and
Bibliographic Services Branch

395 Wellington Street
Ottawa, Ontario
K1A 0N4

Bibliothèque nationale
du Canada

Direction des acquisitions et
des services bibliographiques

395, rue Wellington
Ottawa (Ontario)
K1A 0N4

Your file Votre référence

Our file Notre référence

The author has granted an irrevocable non-exclusive licence allowing the National Library of Canada to reproduce, loan, distribute or sell copies of his/her thesis by any means and in any form or format, making this thesis available to interested persons.

L'auteur a accordé une licence irrévocable et non exclusive permettant à la Bibliothèque nationale du Canada de reproduire, prêter, distribuer ou vendre des copies de sa thèse de quelque manière et sous quelque forme que ce soit pour mettre des exemplaires de cette thèse à la disposition des personnes intéressées.

The author retains ownership of the copyright in his/her thesis. Neither the thesis nor substantial extracts from it may be printed or otherwise reproduced without his/her permission.

L'auteur conserve la propriété du droit d'auteur qui protège sa thèse. Ni la thèse ni des extraits substantiels de celle-ci ne doivent être imprimés ou autrement reproduits sans son autorisation.

ISBN 0-612-11206-3

Canada

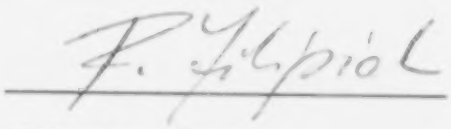
UNIVERSITY OF ALBERTA

RELEASE FORM

NAME OF AUTHOR:	Ray (Rajmund) M. Filipiak
TITLE OF THESIS:	"TIPS" for SUCCESSFUL IMPLEMENTATION of TECHNOLOGY
DEGREE:	Master of Science Degree in Engineering Management (Mechanical Engineering)
YEAR DEGREE GRANTED:	1994

Permission is hereby granted to the University of Alberta to reproduce single copies of this thesis and to lend or sell such copies for private, scholarly or scientific research purposes only.

The author reserves all other publication and other rights in association with the copyright in the thesis, and except as hereinbefore provided neither the thesis nor any substantial portion thereof may be printed or otherwise reproduced in any material form whatever without the author's prior written permission.



12 Coachman Court
Sherwood Park, Alberta, Canada
T8H 1B6

April 12, 1994

UNIVERSITY OF ALBERTA

FACULTY OF GRADUATE STUDIES AND RESEARCH

The undersigned certify that they have read, and recommended to the Faculty of Graduate Studies and Research for acceptance, a thesis entitled "TIPS" FOR SUCCESSFUL IMPLEMENTATION OF TECHNOLOGY submitted by RAY (RAJMUND) M. FILIPIAK in partial fulfilment of the requirements for the degree of Master Of Science in Engineering Management.

Professor J.D. Whittaker	
Supervisor's Name (Type)	Supervisor's Signature
Professor S. Teply	
Committee Member Name (Type)	Committee Member Signature
Professor S.M. AbouRizk	
Committee Member Name (Type)	Committee Member Signature
Committee Member Name (Type)	Committee Member Signature
Committee Member Name (Type)	Committee Member Signature
Committee Member Name (Type)	Committee Member Signature

Date: 29 MAR 94

DEDICATED TO

JMF

ABSTRACT

There is significant uncertainty associated with adoption of new technology. By default the primary concern, in both the private and public business sectors, is with determining whether the technology has a potential to be implemented successfully. This may be even more important than the magnitude of potential profit or benefit.

The research work described herein represents the consolidation of expert knowledge, and experience into an industry consensus baseline. The background information originates from practicing professionals. It is packaged in a neat, concise and easy understandable methodology for assessing the technology implementation potential for success.

The objective of this research was to develop a methodology to aid in the analysis and decision making related to technology implementation. This was achieved by identifying thirty one factors which have been determined to influence the final outcome. By considering these factors, during the analysis of a given scenario, it is possible to identify key driving factors and predict the outcome based on these key factors.

The primary product of this research consists of a database of knowledge on the subject of technology investment and the associated uncertainty. The knowledge is encapsulated in a model (coined the **TIPS** or the **T**echnology **I**mplementation **P**otential for **S**uccess model) which is the heart of the analysis process (referred to throughout this document as the TIPS System, the system, or the method). The computational requirements of the model are handled by a spreadsheet template developed in LOTUS 1.2.3. V.1 for Windows. The implementation / adoption of Expert Systems Technology, into the operations of a department of transportation, is used as the case scenario.

TIPS is a methodology for assisting individuals dealing with technology transfer decision issues. It is presented in a manner specific to transportation concerns, however, the TIPS method is capable for generic application. TIPS assists in the assessment of a candidate technology on all relevant factors, identifies potential weaknesses or problematic areas, recommends remedial action (as an option) to improve the potential and it facilitates for better implementation decisions.

ACKNOWLEDGEMENTS

The research work presented within this document could not have been possible without the help of the following:

Alberta Transportation and Utilities for sponsoring my graduate work in Engineering Management.

Mr. Zach Zacharia, MBA., P.Eng., my colleague at work and my principal sounding board, devils advocate and guinea pig.

Mr. Jan Konarzewski, P.Eng., my supervisor at work and a key supporter for my career development initiatives.

Janice Filipiak, who helped with all the graphic work contained in this document.

Ms. Mary McOuat and Ms. Robyn Corrigal, who reduced the survey data into electronic format.

Professor J.D. Whittaker, Ph.D., my thesis supervisor, for all his assistance and guidance.

All the survey participants and anyone else who contributed and I have missed mentioning.

!!!! A special thank you to all of you !!!!

TABLE OF CONTENTS PAGE NO.

LIBRARY RELEASE FORM

TITLE PAGE

COMMITTEE APPROVAL FORM

DEDICATION

ABSTRACT

ACKNOWLEDGEMENTS

1.0 INTRODUCTION 1

1.1 Document Structure 1

1.2 Background 2

1.2.1 The TIPS System 2
1.2.2 Context 3
1.2.3 Problem Description (Importance of Problem) 5

1.3 Question 5
1.4 Hypothesis 5
1.5 Methodology 6

2.0 RESEARCH CONDUCT 7

2.1 Objective & Scope 7
2.2 Work Plan 7

3.0 THE SYSTEM 9

3.1 Information and Data Collection 9

3.1.1 Literature Search 9
3.1.2 Survey 9

3.1.2.1 Sample Size 10
3.1.2.2 Sample Description 10

3.2 Factors 12

3.2.1 Explanation - Categories, Factors & Attributes 12

3.2.1.1 Overview of Classifications 12
3.2.1.2 Numbering Scheme 12

3.2.2 Detailed Description & Definition 14

3.2.2.1 Communications Factors 14

3.2.2.1.1 Organizational Structure 14
3.2.2.1.2 Technoiogy Transfer Infrastructure 14
3.2.2.1.3 Information Flow 15
3.2.2.1.4 Information Access 15
3.2.2.1.5 Technology Transfer Mechanisms 15
3.2.2.1.6 Technology Transfer Approach 16

3.2.2.2 Financial Factors 17

3.2.2.2.1 Product (Technology) Lifecycle 17
3.2.2.2.2 Research Plan 17
3.2.2.2.3 Resources 17
3.2.2.2.4 Costs 18

3.2.2.3 External Factors 18

3.2.2.3.1 Industry Trends and Developments 18
3.2.2.3.2 Political 18
3.2.2.3.3 Economic 19

3.2.2.4 Human Factors 19

3.2.2.4.1 End User 19
3.2.2.4.2 Manager/Supervisor (Superior of End User) 20
3.2.2.4.3 Technology Champion 20
3.2.2.4.4 Decision Maker 20
3.2.2.4.5 Transfer Team/Agent Attributes 21

3.2.2.5 Corporate Factors 22

3.2.2.5.1 Corporate Culture 22
3.2.2.5.2 Current Corporate Situation 23

3.2.2.5.3 Corporate Policy 24
3.2.2.5.4 Organizational Environment 24
3.2.2.5.5 Representative Staff Profile 25

3.2.6.1 Technology Factors 25

3.2.2.6.1 Solution Feasibility 25
3.2.2.6.2 Technical Risk 26
3.2.2.6.3 Technology Attributes 27
3.2.2.6.4 Technology Effectiveness 28
3.2.2.6.5 Transfer Proposal Attributes 29
3.2.2.6.6 Target Environment 29
3.2.2.6.7 Marketing 30
3.2.2.6.8 Distribution/Dissemination 30

3.3 System Details 31

3.3.1 Functional Specification 31

3.3.1.1 System Users 31
3.3.1.2 System Operations 32

3.3.1.2.1 Basic Requirements 32
3.3.1.2.2 Input 32
3.3.1.2.3 Output 32

3.3.1.3 System Limitation 33

3.3.2 Template 33
3.3.3 Model Description 36

3.3.3.1 Structure 36
3.3.3.2 Working Process 36

3.3.4 System Process & Execution 38

3.3.4.1 The Analysis 41

3.3.4.1.1 Success Potential 41
3.3.4.1.2 Factor Sensitivity & Confidence 43
3.3.4.1.3 Proposed Application to Economic Analysis 43

4.0 RESULTS AND OBSERVATIONS 45

4.1 Survey Responses 45

4.1.1 Level of Response 45
4.1.2 Comparison of Survey Sample Subgroups 45
4.1.3 Comments from Survey Respondents 46

4.2 System/Model 46

4.2.1 The Baseline 46
4.2.2 Data Evaluation 47
4.2.3 Comparison to Another Technology Transfer Model 48
4.2.4 Multi-Attribute Decision Analysis & Utility Theory 48

4.3 Case Scenario Test 51

4.3.1 The Contemplated Technology 51
4.3.2 The Existing Organization 54
4.3.3 Application of the Technology within the Organization 57
4.3.4 The Implementation Success Potential Assessment 58
4.3.5 The TIPS Prediction 62
4.3.6 What Actually Happened 62
4.3.7 Prognosis for the Future 64

5.0 CONCLUSION AND RECOMMENDATIONS 65

5.1 Summary 65

5.2 Further Research and Future System Improvement 66

5.3 Epilogue 67

BIBLIOGRAPHY 69

APPENDIX 74

A.1 Survey Form 75
A.2 Raw Survey Results 80
A.3 Template User Documentation 85
A.4 Template Formulas 90
A.5 Case Scenario Results 96
A.6 Template Perspectives 101

FIGURES

1 Factor Reference Map 13
2 Base Perspective of Template and TIPS Model 35
3 Template (TIPS Model) Symbolism and Statistics 37
4 TIPS System - Process Flow Chart 39
5 De La Garza Technology Transfer Model 50
6 Example of Factor Assessment 60
7 Example of Results Interpretation 61
8 - 11 Template Perspectives . . . . . 102 - 105

1.0 INTRODUCTION

1.1 DOCUMENT STRUCTURE

This document contains seven sections comprising of five chapters, a bibliography and an appendix.

The introduction provides general information regarding the research work. It contains a description of the resulting end product of the research effort and provides the context.

In the second chapter, the objective, scope and work plan for the research work are formalized.

The third chapter contains details for the TIPS System structure and the TIPS Model, the heart of the system used in determining the success potential for technology implementation. Information sources are presented along with details regarding data collection and reduction, the systems functional specifications and operational processes.

Chapter four contains the key observations that where made during the research work. The survey responses and the application of statistics are examined. Another technology transfer model which is used in the Architectural-Engineering-Construction (AEC) industry is presented. Also, an actual case scenario is examined involving Expert Systems technology implementation.

In chapter five some thoughts are expressed with regards to further research and possible improvements to the existing TIPS System. Also, some direction is provided for integrating the TIPS approach into an overall technology transfer strategy.

Citations are found through out this document. However, the highest frequency of this is in Subsection 3.2. It is in this part of the document where the foundation of the TIPS Model is defined. The extensive referencing to the bibliography provides an information sourcing trail for those readers who may be interested in further investigating the information provided.

The appendix contains all the supporting information referred to through out this document. The user documentation for the TIPS Model spreadsheet template is located in the appendix.

1.2 BACKGROUND

1.2.1 THE "TIPS" SYSTEM

An increasingly hostile business environment is forcing organizations to invest in technology in order to improve their position in the marketplace. The survival of any company requires it to be competitive. This need to be competitive forms the fundamental basis for adjudicating acquisition of new or innovative technology (Noori). This is also true from the public agency perspective where the focus is on expenditure restraint rather than competitiveness.

From a fundamental technology transfer perspective it is important for technology implementation decisions to be made in an overall context of the "business battle arena". A need for being able to define this context resulted in the need for research on the subject of technology implementation and the eventual development of the TIPS System. The system is a method of classification and provides an orderly way for evaluating all factors that are pertinent to defining the context.

The primary product of this research work is the knowledge base which is encapsulated in the TIPS Model. The model is the analysis module of the overall TIPS System. The system incorporates the analysis along with other operational procedures required to perform an implementation success potential assessment. A secondary product consists of a spreadsheet program template (LOTUS 1.2.3 V.1 for Windows) which automates the computational requirements of the model.

The TIPS System is basically an analysis tool designed for use during the technology investment / implementation decision process. For new technology to be viable the organization must establish a proper foundation for implementation (i.e., skills, resources, culture). In fact, there are six major areas for consideration, these are:

- Communications
- Financial
- External Influence
- Human Factors
- Corporate Characteristics
- Technology Attributes

The TIPS System evaluates thirty-one consideration factors, which fall into one or another of these six major areas (categories), and rates the technology

implementation potential for success based on these factors. Over two hundred factor supporting attributes have been identified from literature review and surveys. During an evaluation, a case technology is assessed in the context of the environment in which it will be implemented. These attributes will define the context by being identified as either catalysts or barriers to effective technology implementation.

Technology transfer, which encompasses technology implementation, is not an exact science. Subjectivity is inherent in the process. As a more effective surrogate to intuitive decision making, the TIPS System attempts to facilitate a more objective approach. However, it is based on heuristics (observations, opinions, intuition, guessing) and even though quite comprehensive in terms of scope, it is, in fact, subjective and should be used in conjunction with sound judgement.

Ensuring the successful implementation of technology into an organization is complicated and the end result is neither definitive nor certain. Still, this system can play a vital role in the overall technology transfer process. The TIPS System can be used to assist decision makers in making "go" or "no go" decisions regarding investment in technology where the investment magnitude warrants so and where the consequence of failure is significant. The TIPS System can also assist in deciding between alternatives. For this, TIPS can be used on its own or it can be fully or partially incorporated, or it can be used as a precursor, with Utility Theory (Gibson, 1981, Wolf, 1983) or other Multi-Attribute Decision Analysis methodologies (Gibson, 1981, Wolf, 1983, Anandalingam and Ollson, 1988, Falkner and Benhajla, 1990, Datta, 1992, Noori) such as the Analytic Hierarchy Process (Datta, 1992, Noori). Additionally, this system provides information as to where changes can be made (within the technology or the environment) to improve the implementation success potential. Technology implementation has a greater likelihood of success to the degree that barriers to adoption are lowered (Fichman and Kemerer, 1993).

1.2.2 CONTEXT

The marketing of new technologies within the transportation industry requires a knowledge of the potential market, the technology's capability (whether it is a product or process), the user's needs and the current state-of-the-industry. Understanding this context is critical (Betsold and Resnbaum, 1988). The adoption of many new technologies occurs through technology transfer. To that end technology transfer efforts are aimed at surmounting barriers to efficient adaptation of technologies, and to the acceptance and implementation of new and

innovative technologies by organizations.

Betsold and Resnbaum (1988) expand on this context as follows:

First costs, rather than service life costs, are often the primary basis for capital expenditures. In some cases, there are no reliable methods for determining service life. In other situations limited funds must be stretched to meet immediate needs. Regional environmental conditions, as well as the application of local specifications and materials, cause "market" entry by an innovation or new technology, to be time-consuming and costly, thus, often discouraging to its' acceptance. Large, multilevel agencies, such as provincial or state departments of transportation, may pass an innovation from level to level within the organization, requiring a "sales" effort at each level. Delays may be encountered between planning, design, and actual construction stages of a highway project sometimes creating uncertainty as to whether and when an innovation will be accepted and used. Additionally, many new or unique technologies are proprietary and are difficult to introduce because of competitive procurement and rigid specifications set by the agencies.

The most serious problem faced by many new technologies is the lack of acceptable performance evaluation. The type of documentation language used in research is usually laden with cumbersome technical jargon which is difficult for lay persons to assimilate, thus, also frustrating the evaluation process. Several years of field testing and evaluation may also be necessary for acceptance. Most agencies tend to require their own field tests and varying degrees of formal or informal evaluation. Many agencies do not have accelerated testing procedures which would permit the use of performance specifications and invite new and proprietary technologies to compete effectively for the highway market. New products, such as roadside hardware, can present various logistic problems in their method of operation (which may differ from the status quo). It is easier for maintenance forces to work with familiar general-use technologies (products) than with new materials, equipment or design configurations.

For many new innovations, particularly those involving pavements and structures, the engineer cannot risk failure on the inservice highway system because of safety, liability, publicity, and political sensitivity. Thus, there is a continued reliance on traditional, well-tested processes, designs, materials and equipment and a reluctance to experiment with technologies which are outside the normal transportation engineering field.

In many agencies, the rewards for innovation do not balance the risks involved. Although introduction of a successful new innovation is often viewed as part of the job, failure can lead to criticism or loss of public confidence. This institutional

problem increases the natural resistance to change.

1.2.3 PROBLEM DESCRIPTION

Technology transfer is of key importance in the road transportation industry. It has been observed that after locating a potentially viable technological solution (or possibly a number of them) to a particular problem, a standard economic (benefit/cost) analysis is usually performed. This analysis determines which technologies are economically viable.

Typically, transportation organizations are forced to ration resources. Also, these organizations tend to be conservative and cautious in nature, which is a reflection of the industry that they are a part of (Betsold and Resnbaum, 1988). Although not explicitly expressed, failure is not well accepted and a philosophy of avoiding risky ventures prevails. Therefore, it becomes very important to make the correct decision as to which technologies are selected. Since there is uncertainty associated with new technologies, the primary concern is with selecting the one which has the greatest probability of being implemented successfully. It has been suggested by many technology transfer practitioners that this may be even more important than the magnitude of the potential benefit.

1.3 QUESTION

Once the initial economic viability is established how can it be determined if a new or innovative technology is an acceptable risk for contemplated exploitation? Or, what are the chances that the technology willbe implemented successfully?

The significance arises in being able to determine, as objectively as possible, the potential for successful implementation before an actual commitment is made. By the same token, being able to decide between alternatives is also critical.

1.4 HYPOTHESIS

There are a number of factors which influence the implementation of any new technology. These factors should be evaluated in the decision analysis. For any given scenario, it should be possible to identify which factors contribute or hinder successful implementation. Having established this, it should be possible not only to assess the technology implementation potential for success, but, also to identify where remedial action should be initiated to improve the success potential.

1.5 METHODOLOGY

The methodology employed for knowledge extraction and compilation is similar to that used in developing a computer based Knowledge Base Systems (KBS) or as more commonly known Expert Systems (which incidently is the case scenario technology used in Chapter 4). The knowledge was extracted from recent transportation journals and supplemented with information acquired from literature, surveys and interviews. The analysis module (the TIPS Model) that was eventually developed is not a KBS program per se, as originally intended. However, the knowledge has been encapsulated and resides within a conventional spreadsheet program template.

The primary task was to identify as many factors (and supporting attributes) as possible. After completing the identification process, a rating scheme was established for evaluating case scenarios. Validation data collected through the survey process was then analyzed, incorporated into the template and used to establish a baseline for the model. The combined knowledge base and validation data represent the consensus of over one hundred and thirty technology transfer practitioners within the transportation industry with respect to technology implementation. This Industry Consensus Baseline (ICB) can be applied as a control for any case scenario.

2.0 RESEARCH CONDUCT

2.1 OBJECTIVE AND SCOPE

The objective of this research was to develop a methodology (or process) to aid in the analysis and decision making process.

The scope of the research is limited to:

1) the technology transfer process;

2) the import of innovative technology and its' adaptation to an organization's operations;

3) the highway/road engineering industry (Departments of Transportation, Agencies, Academic Institutions and private companies) as the primary source for data collection, hypothesis testing, analysis and evaluation (however, generalized as much as possible to develop a generic model which can be applied for any industry).

Although implicit reference is made to Utility Theory (UT) and Multi-Attribute Decision Analysis (MADA), in depth exploration of these topics are considered to be beyond the scope of this research. The primary intent is to develop a simple linear approach to decision analysis using a broad global approach which focusses on factor identification, explanation and the construction of context. However, a proposal for future integrating of TIPS with UT and MADA is presented in section 4.2.4.

2.2 WORK PLAN

The work plan included the following steps in more or less the sequence presented:

1) Conduct a literature search to establish factors.

2) Identify survey candidates.

3) Initiate a survey to validate information extracted through literature review.

4) Develop a process for analyzing the survey results. Reduce all the information collected. Develop a model based on statistical analysis of data collected. Develop an algorithm for assessing success potential.

5) Define suitable representative case characteristics. Identify interview candidates for trial case scenario.

6) Conduct case scenario interview(s). Experiment with different interview formats to establish the most practical method for data extraction.

7) Trial run a case scenario to test the system and the model. Document observations.

8) Fine tune the system and model based on feedback received during the case scenario test (iterative process may require a number of cycles).

9) Prepare a user guidelines for system and model.

10) Present the concept to select field practitioners for critique. Collect the feedback and use it to fine tune system.

11) Document the evaluation of results, observations, make recommendations and provide conclusion.

12) Submit the documented work for review and incorporate changes resulting from review.

The work plan was initiated in November, 1992 and concluded in December 1993.

3.0 THE SYSTEM

3.1 INFORMATION AND DATA COLLECTION

3.1.1 LITERATURE SEARCH

Much of the information about factors, presented in section 3.2.2, originates from observations and documented experiences dealing specifically with the topic of road transportation technology transfer. However, in all cases the factors are seen not to be unique to this one industry, and thus, it is suggested that they can be treated generically. The complementary information extracted from literature reinforces this claim. It was found necessary to also supplement these factors in order to have this more generic and representative base for proper assessment of technology implementation. To this end the literature search served two purposes. It identified additional factors, and it validated those factors which were already identified. The approach taken was designed to extract, for each factor, only the most important details from the literature and then to interrogate the industry (i.e., via survey) for verification.

3.1.2 SURVEY

The survey was executed between May 1993 and August 1993. The participants of this survey were individuals involved with the function of technology transfer within the road transportation industry. These individuals were selected because of their familiarity and knowledge of the industry and because their fundamental mandate is to deliver technology to the point of adoption / implementation. Also, a few surveys were sent to individuals that have knowledge or expertise related to technology implementation and/or management, however, not necessarily within the road transportation industry. The latter where treated as a quasi control group for comparing the survey results to determine if they are generically representative.

Selecting this group of individuals automatically established a bias within the sample. The bias occurred at a macro and at a micro level. At the macro level, the survey was considered only within the context of the transportation industry. Yet the author is trying to extrapolate the results to a generic application. At the micro level, the survey sample actually consists of a number of subgroups within the sample that have different tasks and objectives. The perspectives of these sample subgroups may be quite different.

The primary objective of the survey was to verify to what degree the identified factors are relevant in assessing technology implementation. The survey was designed to rate the importance of these factors and establish a baseline which could be used in case scenario assessments. A very secondary objective was to identify if bias existed within the sample.

3.1.2.1 Sample Size

A survey was sent to two hundred and eighteen individuals. This group was divided into eight subgroups.

3.1.2.2 Sample Description

Although the premise was to get an overall consensus, the surveyees were grouped in order to determine whether there were in fact any significant differences of opinion between individuals with similar job tasks/functions.

The eight groups of survey targets were:

Group A:

Fifty-two people were contacted at the divisional offices of the Federal Highways Administration (FHWA) in the United States. These offices are responsible for coordinating federal transportation related funding at the state level. The individuals that were contacted are responsible for technology transfer related activities within the respective states.

Group B:

Fifty people were contacted at the FHWA Local Transportation Assistance Program (LTAP) Technology Transfer Centers in the United States. These individuals are center directors and are responsible for technology transfer to local road authorities.

Group C:

Forty-nine people were contacted at the State Departments of Transportation. These individuals are responsible for research and development and/or technology transfer functions for the respective departments.

Group D:

People were contacted at the road authority offices of sixteen major Alberta municipalities. These individuals are identified as technology transfer representatives through which Alberta Transportation and Utilities conducts a passive technology transfer function.

Group E:

Twelve people were also contacted from miscellaneous areas which included the Transportation Association of Canada (TAC), other provincial departments of transportation (only two other Canadian Department's of Transportation have our identified Technology Transfer Mandate), academia, technology transfer information clearing houses in the United States, the FHWA International Cooperation Division (responsible for international technology transfer).

Group F:

Ten people were contacted at the regional offices of the FHWA. The individuals contacted are primarily responsible for coordinating funding to the LTAP centers within their regions.

Group G:

Fourteen people were contacted within the head office of Alberta Transportation and Utilities. These individuals are designated technology transfer agents who represent specific branches (or operational business units i.e., planning, design, etc.) within the head office of the department.

Group H:

Fifteen people were contacted within the field offices of Alberta Transportation and Utilities. These individuals are designated technology transfer agents who represent district offices (i.e., responsible for actual construction and maintenance of the infrastructure).

A copy of the survey form used is located in Appendix A.1.

3.2 FACTORS

3.2.1 EXPLANATION - CATEGORIES, FACTORS AND ATTRIBUTES

3.2.1.1 Overview of Classifications

All the pertinent research information and data collected, relating to technology investment and implementation (i.e., the knowledge base), are broken down into three levels. Each level is progressively more specific.

The knowledge base is divided into six thematic groupings. This is the first level. The groupings are referred to as Factor Categories. These categories address a basically common subject area. The knowledge base is further subdivided into thirty-one yet smaller groupings referred to as Factors. It is at this level that the system performs the success potential analysis. Factor Attributes define the next and final level. Each factor has a varying number of factor attributes. Although not necessarily interrelated, these attributes support the theme of the respective factor and better define the context for the factor. There are over two hundred attributes identified in the model.

3.2.1.2 Numbering Scheme

The numbering scheme was chosen to facilitate factor identification. The factor ID is used for sorting and other types of data manipulation during analysis.

The numbering scheme subscribes to the following alphanumeric standard:

C4 = factor category => Human Factors

F1 = factor => End User

A1 = factor attribute => Attitude (towards technology).

Refer to the Factor Reference Map in Figure 1.

FIGURE 1 FACTOR REFERENCE MAP

3.2.2 DETAILED DESCRIPTION AND DEFINITION

Each factor will be described in some detail in the following chapters. The expert system scenario (Chapter 4) will be examined using sample questions and/or statements that should be used in a typical interview forum when extracting data about a particular case scenario (this was actually done during the case scenario test).

Before reviewing these factors it should be noted that there is some repetition of factor attributes, however, the context does differ in each case. Also, the validity of the overall success potential rating is subject to the ability to estimate the level of these attributes (only if they apply) with a reasonable amount of understanding and confidence.

3.2.2.1 Communications Factors

Diffusion of information about new technology is predominantly a process of communication (Fichman and Kemerer, 1993). Anything that impedes communication within the organization, as well as within the environment it interacts in, will jeopardize the successful implementation of the technology within the organization (Katz, 1988, p403).

3.2.2.1.1 Organizational Structure

The structure of an organization will either facilitate or impede communication. Effective decision making regarding implementation strategies and procedures will becomes increasingly frustrated with increased decentralization of decision making authorities. Closely related to this is the degree of geographic dispersement of corporate offices (Noori, Filipiak, 1990, Katz, 1988, p691). Hierarchical nesting of authorities/decision makers can also frustrate communication as each level may present its own agenda which may or may not be conducive to the implementation strategy.

3.2.2.1.2 Technology Transfer Infrastructure

The existence of a technology transfer infrastructure which facilitates communication channels for delivering information regarding new technology will certainly increase the success potential of the contemplated implementation. A contingent of staff (or possibly one individual) designated as a transfer team/agent charged with a technology transfer mandate would be fundamental to this infrastructure (Large and Baclay, 1992). The process should encompass transfer

mechanisms (Filipiak, 1990) and processes (Schmitt, Mulroy and Beimborn, 1994) designed to facilitate effective transfer and integration of technology into the organization's operations.

3.2.2.1.3 Information Flow

Effective technology transfer (conducive to successful implementation) is best done through multiple communication channels, both internal and external to the organization (Schmitt, Mulroy and Beimborn, 1994). Technology related information should be allowed to flow freely through these channels and should not be stifled by formal communication protocols (Rubough Jr., 1993). Informal contact through mobility of staff in the organization, and sometimes within the industry as a whole, is also conducive to information sharing and technology adoption (Katz, 1988, p442, Tushman and Moore, 1988, p565). So is the ability by different management levels to articulate concepts (Burgleman and Maidique, 1988, p348). The existence of an internal network of gatekeepers which are not aligned with the organizational hierarchy also supports informal information flow (FHWA-RD-91-010, 1990, Filipiak, 1990, Katz, 1988, p691).

The existence of an industry interface is critical for an organization to remain in touch with the environment within which it interacts (Filipiak, 1990). The interface should be with an existing external network through which technology transfer occurs within the industry (FHWA-RD-91-010, 1990, Filipiak, 1990).

3.2.2.1.4 Information Access

Part and parcel with information flow is the access to information. Obviously, the more facilities there are through which to obtain information, especially information outside the organization, the more qualified will the final implementation decision be (Katz, 1988, p691). The facilities could include electronic bulletin boards, which provide virtually boundary-less electronic communication capabilities (Jones and Lockhart, 1990). They could include other query response systems such as libraries services which can, for example, provide information searches on world wide research databases. Certainly, the existence of training facilities, demonstration and circuit rider programs would constitute effective supplemental means for information access by all organization staff (FHWA Video, 1992).

3.2.2.1.5 Technology Transfer Mechanisms

The technology transfer mechanisms encompass the task of dealing with an

overabundance of information and selecting the right (pertinent) information and delivering it to the right target (FHWA Video, 1992). To accomplish this, transfer agents should have an understanding of the current processes employed within the operations of the organization. This is critical for establishing the organization's technological needs. Once the needs are established, a mechanism must be in place for the search and capture of the technology. This involves thoroughly interrogating the industry/market for technological solutions.

The next phase of the process would involve adapting and translating usually highly technical information into a form that can be assimilated by the organization. This would include testing and evaluating the technology to determine its' attributes and how they may fit into the operations.

The final phase of the process involves mechanisms for packaging or preparing the information on the technology for distribution. This may involve the use of various media production methods to appropriately package the information into a format that is target specific. The dissemination of this information would involve targeting and delivering the packaged information to specific individuals within the organization (Filipiak, 1990).

3.2.2.1.6 Technology Transfer Approach

The approach taken basically addresses the issue of how the organization, and the individuals in it, are exposed to the technology that is being contemplated for implementation (Schmitt, Mulroy and Beimborn, 1994).

The initial awareness and eventual acceptance of the technology are a function of the conciseness and clarity in which the information is packaged (Schmitt, Mulroy and Beimborn, 1994). The information must be communicated in a palatable manner taking into consideration possible biases or special interests of the targets. The biases will vary for each target. Proper target identification is also an important consideration (Jones and Lockhart, 1990).

The relationship between the source and the target offers a unique opportunity to gain valuable insights into the characteristics of the target audiences and the potential barriers which might prevent adoption of a new technology (Noori and Radford, 1990, p91). Informal relationships, formed through personal contact (Schmitt, Mulroy and Beimborn, 1994) or "face to face" interaction (Katz, 1988, p691, Rubough Jr., 1993, FHWA Video, 1992), tend to be most effective. Involving the client (Jones and Lockhart, 1990) or the end-user in the evaluation process (Noori and Radford, 1990, Jones and Lockhart, 1990) will win them over,

hence improving the chances for successful implementation. Also, new knowledge is inherent to new technology which usually presents a requirement for new or updated skills. Therefore, facilitating the training requirements is very important (Shrieves, 1992, Noori and Radford, 1990, p91).

Finally, consideration should be given to identifying what is driving the technological need and then appropriately adapting the technology transfer approach (i.e., bottom-up versus top-down) (De La Garza and Mitropoulos, 1993, p436). Both pull and push approaches should be examined (Large and Baclay, 1992). For example, a grass roots needs driven scenario will pull the acceptance of the technology but will require a bottom-up push approach targeted at senior management to achieve their concurrence.

3.2.2.2 Financial Factors

3.2.2.2.1 Product (Technology) Lifecycle

A primary concern is the fiscal justification in terms of returns on the investment and the irreversibility of the investment, where adoption requires investments in unsalvageable products (Fichman and Kemerer, 1993). The payback period and the significance of the payback are intrinsic to the justification (Noori). The life of the technology, in terms of economic returns to the organization, will certainly have impact on the adoption decision. Also, prior technology drag, where a prior technology provides a significant network benefit because of large and mature installed base, may drastically affect the economic viability of the new technology if the supporting infrastructure has to be modified or replaced (Fichman and Kemerer, 1993).

3.2.2.2.2 Research Plan

A resource commitment is absolutely essential for proper adoption of new technology. Resource availability, allocation (Noori and Radford, 1990, p91, Burgleman and Maidique, 1988, p39, p41 tables) and financial backing (Noori and Radford, 1990, p91) will be required. To that end there should exist a research strategy, in which research funding is planned for, and which is congruent to an overall organizational strategy which covers fiscal planning.

3.2.2.2.3 Resources

The availability of human, financial and capital resources should be considered prior to implementation. Resources for providing user assistance may also be

required for various things, such as training. Sourcing of resources should be established beforehand (FHWA-RD-91-010, 1990). The availability of external resources through cooperative ventures or other arrangements may enhance the success potential for adoption (Shrieves, 1992).

3.2.2.2.4 Costs

A Chief Executive Officer should care about which technologies are likely to succeed because the cost of choosing an unsuccessful one can be substantial and recovery very difficult (Fichman and Kemerer, 1993). Areas that should be investigated are the ability to determine the costs for developing a proof of concept as well as for developing prototypes. The ability to absorb costs associated with preliminary development should also be looked at (Noori). These types of economic evaluations will identify the point of diminishing returns regarding the investment in particular technology (Tushman and Moore, 1988, p215).

3.2.2.3 External Factors

The decision to adopt technology is heavily influenced by environmental factors (De La Garza and Mitropoulos, 1993). These are the events occurring in the industry, market, country and the world in general, within which the organization interacts.

3.2.2.3.1 Industry Trends and Developments

It is important for an organization to be in touch with what is going on in the industry (FHWA Video, 1992). Being in touch allows for continuous awareness of the state of industry growth (Tushman and Moore, 1988, p689) and provides indication as to what forces are driving the implementation of the new technology (Noori and Radford, 1990, p495). The organization can then anticipate future technology changes in the industry, thus allowing it to position itself accordingly in the market (Tushman and Moore, 1988, p215). The avoidance of effort duplication may be one reason. Development of cooperative alliances may be possible on the other hand. Understanding the state of technology development, the competitor's innovative strategies and the multi-industry evolution will assist in directing investment in proper new technologies which will maintain the organization competitiveness (Burgleman and Maidique, 1988, p39 & 41).

3.2.2.3.2 Political

Government intervention (Noori and Radford, 1990, p449) can influence the

technology implementation success potential by supporting an organization's initiative through subsidies (i.e., grants and tax incentives) or by hindering it through regulation (Schmitt, Mulroy and Beimborn, 1994) (i.e., environmental sensitivity/impact (FHWA Video, 1992)). The very type of organization, whether it is a government agency or a private corporation, may be reason for different treatment by government. The state of current taxes and legislation will reflect the government's philosophy toward new technology (FHWA-RD-91-010, 1990). Other social political factors such as unemployment (usually regulated by government or have union influence) can influence implementation decisions (Noori and Radford, 1990, p408 & p487). The government's political stability and the current government fiscal situation will have some bearing.

3.2.2.3.3 Economic

Social-economic constraints, a shrinking or growing economy (i.e., recessional versus inflationary economy) and the current cost of money or capital financing will most certainly affect the adoption decision (Noori and Radford, 1990, p495). These considerations define the current economic reality and will determine the economic viability of a new technology.

3.2.4.1 Human Factors

Ultimate users of new technology must do something different from what they have done in the past. They must change their behaviour patterns. A consequence of this is that it cannot be expected that the recipients will respond to new technology quickly. They must not only assimilate facts relevant to the technology, but also change behavioral patterns that would lead them to use the technology. Also, it is human nature to resist ideas, especially those originating from outside of the organization, and this can lead to myopia or tunnel vision (Katz, 1988, p442). A clear implication is that technology transfer requires time, patience and opportunities to experiment (become familiar with) a new technology (Bunting, p17).

3.2.2.4.1 End User

It is evident that the success of technology implementation efforts depends on knowing the users and their needs, and being able to identify potential opportunities or barriers which will influence a user's decision to adopt a new technology (FHWA-RD-91-010, 1990, p21).

The successful implementation of technology depends on the end user actually using or applying the subject technology. In evaluating whether this will be the eventual case we need to determine what the end user's attitude is toward

technology and how the end user feels about the change which usually accompanies implementation of new technology (FHWA-RD-91-010, 1990, FHWA Video, 1992). The level of understanding of the technology that the end user possesses is also important. The more familiar the end-user is with the concepts of the technology the more likely one is to be accepting of it. We also need to know what skills, if any, the end user possesses that are directly applicable to the subject technology (Noori and Radford, 1990, p91). Finally, it is critical to establish how the end user perceives the technology with respect to their work, whether as a threat or a benefit (Schmitt, Mulroy and Beimborn, 1994).

3.2.2.4.2 Manager/Supervisor (of the End User)

The decision to adopt technology is influenced by management's attitude toward technology (Katz, 1988, p280, De La Garza and Mitropoulos, 1993). Also, like the end user, management should have a clear understanding of the technology and a defined goal of what they want to achieve. Sincere commitment, backed by support, in the form of resource investment, is necessary if the technology is to have a chance at all (Noori and Radford, 1990, p91).

3.2.2.4.3 Technology Champion

Sponsorship by a single entity (person, consortium), in other words a technology champion, helps to define the technology, set standards, subsidize early adopters, and promote adoption of a technology (Katz, 1988, p442, Fichman and Kemerer, 1993). The attitude of this entity must also be one that is conducive to successful implementation. The technology champion may or may not be a gatekeeper within an organization. Regardless, the level of the position occupied in the hierarchy has a great bearing on the ability to influence the final outcome (Katz, 1988, p691, De La Garza and Mitropoulos, 1993, p436, Tushman and Moore, 1988, p565).

3.2.2.4.4 Decision Maker

The decision makers, usually senior managers, should exhibit visionary leadership (Burgleman and Maidique, 1988, p568 Tushman and Moore, 1988, p689). They need to possess an intuitive feel for the future in a changing world. They should possess the power to influence the direction the organization embarks by supporting technologies that will become fundamental to their organization's future existence (Tushman and Moore, 1988, p565). As it is with the other key players, it is critical for decision makers to have an understanding of the possible

implications resulting from the implementation of the technology. They must believe technology choices are business decisions that have potential to realize benefits to the organization if executed properly (Tushman and Moore, 1988, p236).

3.2.2.4.5 Transfer Team/Agent Attributes

The individuals within an organization charged with executing technology transfer should possess certain character traits for effecting successful implementation(Large and Baclay, 1992). They should possess intelligence (Gibson, 1981, Schmitt, Mulroy and Beimborn, 1994) without being overly intellectual, thus, possibly jeopardizing their credibility (Large and Baclay, 1992) in the eyes of the other key players. They must be able to project themselves and view the technology from the user's perspective (Tushman and Moore, 1988, p565).

They should possess general competence (Gibson, 1981) in the form of business empathy or business sense (Large and Baclay, 1992). As well, they should possess technical competence (Gibson, 1981, Shrieves, 1992) or a certain level of cursory expertise regarding the candidate technology to be able to articulate (Schmitt, Mulroy and Beimborn, 1994) between information source groups and target groups.

Effective agents should exhibit independence (Gibson, 1981) in planning and executing actions. In terms of effectively interacting with people, they should possess people skills (Schmitt, Mulroy and Beimborn, 1994) which include leadership, as well as team play (Gibson, 1981), or the ability to work in a team environment with individuals with diverse backgrounds.

Since technology implementation is fraught with obstacles and resistance, persistence will be the order of the day for the agents. This will challenge the agents' creativity in developing new strategies to overcome these barriers (Gibson, 1981). The agent will have to be fully committed to the implementation initiative (Large and Baclay, 1992).

In summary, the agents play multiple roles within the organization. They may find themselves as the technology champions and/or the technology gatekeepers. Whatever the role or roles, interpersonal skills such as oral communication and the ability to overcome technical language and local language coding schemes will greatly assist in transcending organizational boundaries. These skills will also be important when linking to external sources of information (Katz, 1988, p403).

3.2.5.1 Corporate Factors

The decision to adopt technology is also heavily influenced by organizational factors (De La Garza and Mitropoulos, 1993, Noori). Organizations are more likely to be willing and able to adopt technologies that offer clear advantages, do not drastically interfere with existing practices, and are easier to understand. Adopters look unfavourably on innovations that are difficult to evaluate or which benefits are difficult to see or describe (Fiehman and Kemerer, 1993).

3.2.2.5.1 Corporate Culture

Corporate culture is an intangible yet powerful influence on an organization. This influence purveys itself into all operational and functional areas. The free flow of ideas, trust among staff, sense of common purpose and the ability to integrate (i.e., overcome functional barriers are examples of culture based characteristics) (Tushman and Moore, 1988, p689). The culture defines the character of the organization and is expressed by the behaviour of its staff, how they interact, react and influence each other. The culture tends to be an intrinsic, although not always obvious, part of the end products produced by the organization.

Many things contribute to the overall culture of the organization. The primary influences are the overall corporate (Filipiak, 1990) and individual management philosophies (Katz, 1988, p442, Tushman and Moore, 1988, p236) toward technology. This can be determined by observing whether there exists true executive support (Filipiak, 1990). The support can take many forms, it can be in the form of allowed dreaming (Coates, 1984) or allowed slack time (Katz, 1988, p442) for creative experimentation (Katz, 1988, p201). Another indicator may be the existence of reward systems designed to incite innovation (Filipiak, 1990, Katz, 1988, p403 & 442, Burgleman and Maidique, 1988, p137).

Another good indicator is the way the organization challenges problems (Kepner and Terque, 1981, LES Video, 1988) by way of proactively versus reactively challenging existing paradigms (Coates, 1984). Yet another is the organization's openness to methods used successfully by other organizations and its' willingness to abandon old ways (Tushman and Moore, 1988, p689). Another is the way the organization goes about removing barriers such as outdated policy. Another external indicator would be the corporate image and reputation within the industry.

In summary, business focus, entrepreneurship, excellent communications, ethics policies, fierce activism for promoting change, encouraged risk taking and failure

tolerance are all the basics of a culture conducive to technology adoption. A "hands-on" top management who understand the fundamentals of the operations and who are involved in projects with strategic impact potential will instill a sense of integrity, self understanding and pride within the organization (Tushman and Moore, 1988, p689).

3.2.2.5.2 Current Corporate Situation

The current fiscal situation of the organization will likely be a consideration when arguments are presented for adoption of a new technology. This situation will be tempered by a dualism effect or a need to balance resources to support today's production and the new technologies that will support business in the future (Katz, 1988, p442). This will determine the current priority and urgency of the technological needs in the context of the available resources (Noori). The ideal situation would be if an organization can except failures and/or can handle failures that are not fiscally fatal (Noori and Radford, 1990, p495).

A a new technology will depend on an adequate existing infrastructure (Noori and Radford, 1990, p495). The infrastructure may be required within and outside of the organization (Katz, 1988, p280). This will affect the way the technology should be implemented. The organization size (Noori and Radford, 1990, p91, Tushman and Moore, 1988, p565) and the technology capabilities (De La Garza and Mitropoulos, 1993, p436) will suggest different rates and styles of implementation. A technology adoption process will be necessary, with proper assignment of critical staff who have been identified to carry out the process (including idea generation, entrepreneuring, championing, project leading, gatekeeping, sponsoring and coaching) (Tushman and Moore, 1988, p310).

The availability of organizational expertise versus outsourcing for external solutions is another consideration. The organization should be able to facilitate at least one of the two. Of course the organization has the option of not adopting the new technology if expertise is not available. Then, the impact of doing nothing should be explored (Noori).

Organizations cycle through alternating states of order (stability) and disorder (change) (Tushman and Moore, 1988, p689). This may happen in harmony with greater external influences such as economic cycles or it may happen due to forces occurring strictly internally. It is usually the "change" cycle which will create motivation for adopting a new technology by identifying potential technological discontinuities (Tushman and Moore, 1988, p215). Under the new reality (resulting from the change) these discontinuities, if not addressed, can be

potentially fatal to the organization.

3.2.2.5.3 Corporate Policy

It is important to determine how technological issues within the organization are recognized by senior management (Noori). Maybe more importantly, it should be determined whether management uses technology to implement strategic objectives (Burgleman and Maidique, 1988, p137). For example, is technology development part of the corporate (business) strategy (Tushman and Moore, 1988, p229, Burgleman and Maidique, 1988, p137)? Is technology treated as a resource? Is the technology investment strategy in line with the business strategy? The answer to these questions will constitute the corporate technology policy on innovation and adoption. As part and parcel of this policy, there should exist a corporate technology transfer mandate which supports an overall organizational mandate . The policy should also facilitate support mechanisms (i.e., budgets (Katz, 1988, p442)) required to execute the mandate and controls which are conducive to successful technology adoption (Noori).

3.2.2.5.4 Organizational Environment

If an organization is flexible, heeds rigidity and control, or does not suffer from organizational inertia, then there is more likelihood of successful implementation (Tushman and Moore, 1988, p565). Rigid organizational bureaucracy (i.e., strategic overplanning, redundant or untimely policy, a tendency toward paper studies in lieu of immediate decision making, etc.) will impede technology adoption (Katz, 1988, p433). An understanding of the political nature within the organization is necessary, as at times, manipulation of it will be required to achieve a successful outcome (Burgleman and Maidique, 1988, p348).

Management should have a good understanding of the corporate technical environment (Large and Baclay, 1992, Burgleman and Maidique, 1988, p39 & 41). They must be aware of technological threats and opportunities (Tushman and Moore, 1988, p236) and should anticipate or have a good sense of timing for technology evolution (Tushman and Moore, 1988, p229). They should possess receptiveness toward ideas generated outside of the organization and be prepared to exploit them when appropriate (Large and Baclay, 1992). Management should ask the question "Is the organization based on technology?", and act accordingly (Noori and Radford, 1990, p486). Management should facilitate conditions for change by providing the opportunity to experiment and fail (Bunting). They should generate excitement (Large and Baclay, 1992, Bunting) around the new technology and support user involvement as much as possible (a truism of Total

Quality Management). This can be termed as strategic management capacity to deal with entrepreneurial behaviour (Burgleman and Maidique, 1988, p39 & 41).

An organization should have a crowded R&D agenda requiring rationing of resources (Large and Baclay, 1992). This will motivate a proper assessment of the candidate technologies.

The issue of rights ownership regarding patents, copyrights, industrial designs and alike, should be resolved at the onset of the implementation process if the issue arises at all, a win-win strategy will be most conducive to successful implementation in all cases (Bunting).

3.2.2.5.5 Representative Staff Profile

The influence of the R&D Director is a key considertion in the adoption process (Large and Baclay, 1992). The role of this position is fundamental to building the necessary organizational culture. The staff, on the other hand, make the organization and embrace the culture. If an atmosphere of trust exists between these people, especially the parties involved in a technology transfer process, greater potential for successful implementation will be apparent (Bunting). This trust will lend itself to use-inventor cooperation as well as team cooperation and a consensus among organizational teams or business units (Large and Baclay, 1992). Also, trust will dispel the perceived threat (as often associated with new technology) and will facilitate the necessary behavioral changes that are sometimes required to accommodate new technology.

In general, a positive staff profile within the organization will accommodate anticipation and impatience for realizing results and will lessen the aversion to complex technologies (Bunting).

3.2.6.1 Technology Factors

The decision to adopt technology is influenced by the technology itself (De La Garza and Mitropoulos, 1993, Noori). This is a fundamental truth. All other factors being equal, if the technology fails to live up to the expectations of the eventual users, then its implementation will not be successful.

3.2.2.6.1 Solution Feasibility

Feasibility suggests that the new technology will be a conducive solution for the problem at hand (Noori). To ensure this is so, a thorough technology evaluation

using performance measuring criteria, testing schedules and follow-up procedures will likely be necessary (FHWA-RD-91-010, 1990). Adequate prototype development time and testing time may be required (Noori). Accelerated testing procedures may also be required (Filipiak, 1990). Provisions may have to be planned for things such as additional R&D (FHWA-RD-91-010, 1990) that may be required to adapt/customize the technology, training (Noori) to address any skill requirements (FHWA-RD-91-010, 1990) for users of the technology, or any other resource requirements (FHWA-RD-91-010, 1990, Tushman and Moore, 1988, p236) required to support implementation. Within the evaluation, the possibility of existing viable alternatives should be examined as well (Noori).

Logistics is another key consideration (FHWA Video, 1992). This may involve issues such as integrating the technology into an existing infrastructure or possibly the need for establishing a new one. For example, in a manufacturing setting the existence for new production scaling processes (i.e., new tooling for robotic automation) may be required prior to technology implementation (Noori). These kinds of operational factors must be examined (Noori and Radford, 1990, p368). Pursuit of perfection or optimization versus good enough end product quality and the level of technology complexity (i.e., appropriate for given application) are possible considerations as well (Katz, 1988, p433, Noori and Radford, 1990, p495).

A business perspective analysis should be performed and should include a technical and commercial feasibility study (Burgleman and Maidique, 1988, p348), a cost-benefit analysis (Noori and Radford, 1990, p487), an impact analysis and competitive pressures analysis. The technology should be congruent with corporate goals and should support areas central to future objectives of the organization (Gibson, 1981, p163, 164). The possibility of spinoffs such as sale or leasing of proprietary technology (licensing) should also be investigated (Fichman and Kemerer, 1993).

3.2.2.6.2 Technical Risk

The size of risk is an important consideration especially when investment is large and failure may be financially fatal to the organization (Hillier). Unfortunately, determining the risk in many cases is a subjective estimation of probability for successful implementation (Gibson, 1981, p315). Success potential is a secondary consideration as the potential profitability is what usually outweighs the risk (Fichman and Kemerer, 1993). To that end the ability to obtain accurate costing information is important to be able to perform representative Cost-Benefit estimation (FHWA-RD-91-010, 1990).

From the technical perspective, a previous performance history (FHWA-RD-91-010, 1990) of the technology should greatly assist in assessing the risk. Information on the capability of the technology (Filipiak, 1990) to solve similar problems and any drawbacks (FHWA-RD-91-010, 1990) or side effects should be readily available. Issues such as risk of stranding or the failure of the technology to achieve critical mass of adoption, in past implementation attempts, may become apparent. This may also bring to the forefront issues of transient incompatibility as related to the existence of networks of early adopters of the technology necessary to achieve that critical mass (Fichman and Kemerer, 1993).

Also, from a technical perspective, there is the issue of prototype efficacy which refers to several dimensions of technical risk (i.e., will the prototype work, will it work in the expected range of design conditions, will it produce a significant user benefit, will it appear producible, and is it safe) (Large and Baclay, 1992, p20).

Of course, to begin with, the technology broker must understand the problem (Noori) being addressed to properly monitor or track (Burgelman and Maidique, 1988, p137) the technology, assess whether it is proven or radically different (Noori and Radford, 1990, p91), and be able to make qualified comparisons. The broker should also have a technical understanding of technology benefits, limitations, fit or capability for integration (Katz, 1988, p442, Tushman and Moore, 1988, p215). The final result of this type of assessment should be a qualified failure predictability (Noori) assessment of the contemplated technology.

3.2.2.6.3 Technology Attributes

The state-of-the-art (Noori and Radford, 1990, p91) and state of maturity (De La Garza and Mitropoulos, 1993, p436, Tushman and Moore, 1988, p215) of the technology are important considerations in timing for exploitation. So too, is the technology growth potential (Katz, 1988, p442). An assessment of the candidate technology's fit and mutual support of existing technologies (both internal and external) may be important if there is interdependence on other technologies (this is really the infrastructure issue again) (Noori and Radford, 1990, p91).

Other attributes that influence the potential for adoption include the degree to which the technology is:

- Applicable to the problem at hand;
- Reproducible and Transferable, thus addressing the economies of knowledge leveraging (FHWA-RD-91-010, 1990);

- Practical in terms of triability (i.e., experimenting without great investment of resources) (Noori);
- Compatible with existing procedures, existing values, skills, work practices and existing technologies (Katz, 1988, p442);
- Adaptable in terms of customization (Filipiak, 1990);
- Workable in terms of complexity and relative difficulty to understand and use;
- Documentable in terms of communicating observable results and benefits (Fichman and Kemerer, 1993);
- Implementable, possibly incrementally, thus, not overextending the amount of up-front investment (FHWA-RD-91-010, 1990);
- Competitively advantageous (Burgleman and Maidique, 1988, p31);
- Improves quality of product, service, life and safety (FHWA Video, 1992);
- Sensitive to the environment, for example, through energy conservation (FHWA Video, 1992);
- Technically superior over the technology that was superseded (Fichman and Kemerer, 1993).

3.2.2.6.4 Technology Effectiveness

To be adopted the technology must be effective (Noori). To be adopted the technology must be of real value where benefits exceed the costs to the organization (De La Garza and Mitropoulos, 1993). The immediacy and the duration of the benefits are also important considerations. The technology must be technically correct and reliable to be properly utilized by the end users (FHWA-RD-91-010, 1990). Also, transition to new technology should result in superior performance improvements over the current situation within the organization (Filipiak, 1990, Tushman and Moore, 1988, p215).

Primary indicators of the effectiveness of the technology are the degree to which the technology adequately and directly addresses the problem and to which the results are tangible and quantifiable (Noori).

Other considerations, possibly of lesser significance, could include:

- the degree to which the technology is easy to evaluate (Filipiak, 1990);
- the possibility of spinoff applications to other problems or support of other research efforts (FHWA-RD-91-010, 1990, Noori);
- contribution to the State-Of-The-Art (Noori).

3.2.2.6.5 Transfer Proposal Attributes

The successful implementation of a technology will also depend on the arguments presented for its' justification. The role of the proposal (Large and Baclay, 1992) is to define how adopting a technology will affect other components of the organization such as marketing function, human resources, finance and accounting, the overall structure, and the balance between flexibility and control (Noori and Radford, 1990, p 321).

Many questions need to be answered in the proposal, for example, "Why is the technology needed (i.e., displacement of old technology (Noori and Radford, 1990, p483, 484))? When should it be introduced (i.e., timing)? Where should it be introduced first? How should it be introduced (i.e., multi phased implementation allowing enough time for proper assimilation by end user while still maintaining a cognisance of the rapid pace of technology evaluation) (Noori and Radford, 1990, p91)?"

The proposal should address the issue of profit, whether it is both sustainable and substantial. Also, whether the technology fits strategically at all levels of the organization that it affects. It should address the marketing fit - whether marketing plans can accommodate the technology being transferred, and the financial fit - whether fiscal requirements (i.e., type of funding - phased versus one-time) can be accommodated in the organizations fiscal planning. Basically, it needs to establish the technology's fit into the overall organizational context. It should also address issues already elaborated upon earlier in the document such as user-value, transfer cost and prototype efficacy (Large and Baclay, 1992, Fichman and Kemerer, 1993).

Finally, even if the new technology is as good as it is built up to be, the proposal should explain what needs to happen before implementation is initiated. It should explain in detail how much leverage the new technology will exert on the total system (Noori and Radford, 1990, p495)?

3.2.2.6.6 Target Environment

The characteristics of target market will, to a greater extent, determine the type of approach taken during implementation (Burgleman and Maidique, 1988, p419, Noori). To determine whether the appropriate target has been identified, we need to reflect upon the technology and establish to what degree the end user's needs are being addressed. Then, when we refocus on the end-user we should establish if anticipation exists for the technology to be a solution to their problem (FHWA-

RD-91-010, 1990). To be able to assess these two issues properly, the potential end users should be involved in the evaluation process from the conceptual stage and onwards.

In the greater context, an examination of the management goals of various business units as well as the overall organizational goals should assist in establishing proper targeting of the technology.

In preparation for technology deployment, the method of operation of the potential target environment should be reviewed. If required, modification should be planned for. Possible acceptance barriers should be anticipated and planned for as well. If the technology lends itself to this, an adequate number of technology units should be available to supply all who have indicated a need or interest (Filipiak, 1990, FHWA-RD-91-010, 1990).

3.2.2.6.7 Marketing

The fundamental and most important concept in marketingis to understand and satisfy the intended target's need. The other important aspect is the marketing plan itself (Large and Baclay, 1992, p16). Therefore, a marketing strategy should be part of the organization business plan with adequate resources reserved for technology promotion. The promotion should focus on raising the visibility of the technology and bringing about awareness throughout the organization. Closer relationships should be established with identified targets, such as the potential end users as well as the eventual decision makers (Tushman and Moore, 1988, p565, FHWA-RD-91-010, 1990, Shrieves, 1992, Large and Baclay, 1992).

Execution of the marketing strategy and technology promotion can be tempered with the fact that implementation efforts will benefit from an extended period of widespread expectations, by the targets, that the technology will be adopted in the future (Fichman and Kemerer, 1993).

3.2.2.6.8 Distribution/Dissemination

The deployment of the technology should begin only when every aspect of implementation is ready. Provisions should be arranged for training, technical assistance and any other resource requirements anticipated for supporting implementation. Appropriate implementation timing and an appropriate technology introduction rate should have been established with sufficient warning provided for intended targets. All supporting documentation should have been prepared (in target specific formats) and an adequate distribution system should be

in place at time of distribution (FHWA-RD-91-010, 1990, Shrieves, 1992, Schmitt, Mulroy and Beimborn, 1994).

3.3 SYSTEM DETAILS

3.3.1 FUNCTIONAL SPECIFICATION

3.3.1.1 System Users

The intended users of the TIPS System are individuals within an organization that are in one way or another involved in technology implementation. These individuals need to make sound decisions regarding the investment in technology. In some cases the proper decision may be critical to the future health of the organization. The TIPS System can provide objectivity and rational to these decisions. An example of possible users include the following:

Technology transfer agents who are responsible for the search, adaptation or translation, packaging and dissemination, training and ensurement that a new technology is properly implemented, accepted and used to its full potential by a target user.

Managers within research related areas who are responsible for technology transfer functions.

Managers or those charged with the responsibility of making decisions as to whether a technology is considered for implementation within the organization.

Managers or those charged with budgeting responsibilities which encompass evaluating the cost of new technology.

Those charged with strategic and business planning responsibilities within the organization.

Individuals who are being trained to perform any of the above noted functions.

3.3.1.2 System Operation

3.3.1.3.1 Basic Requirements

The user of the TIPS System is required to be familiar with the particular scenario being analyzed and should have access to financial information regarding the technology under consideration. The user is also required to be familiar with the financial methodologies used within the organization. Finally, the user should be familiar with the organization's culture. This background is required in order to properly rate the factors.

3.3.2.3.2 Input

There are thirty-one factors in the TIPS Model (template). The user will review and assess each factor within the context of the scenario (i.e., technology) being evaluated. In evaluating these factors, the user will provide numeric ratings for:

- factor applicability (to the scenario);
- contribution type (supportive or hindering to successful implementation);
- degree of contribution; and
- level of confidence (of the ratings assessed on all of the above).

The numeric ratings have counterpart subjective ratings.

The input user-interface also provides a facility for textual annotation.

Refer to Figure 6 in section 4.3.1.4 for an example of input for a typical factor assessment.

3.3.1.3.3 Output

The output will include a summary of the inputs provided by the user. The output will provide the following:

- a list of the key driving factors influencing the final outcome;
- a potential success rating (or risk of failure rating) and a sensitivity range (also confidence rating) for each key driving factor;
- an overall value rating of the potential for successfully implementing the technology under consideration;
- recommended actions for each factor, factor category and overall scenario;

- a suggested estimate of a discount rate to be used in an economic analysis (using the discounted cashflow method).

Refer to Figure 7 in section 4.3.1.4 for an example of typical output.

3.3.1.3 System Limitations

This system is designed to operate as a "one-run-system" where only one technology evaluation scenario can be analyzed at a time.

The system, as it stands, was designed within the boundaries identified in the research scope in Chapter 2. Some modification of the system may be required for generic application.

3.3.2 TEMPLATE

The template (filename: MODELRAW.WK3) was designed using LOTUS 1.2.3 for Windows V.1. It is fully automated and dynamically linked to the database containing the raw survey results (filename: SURV_RAW.WK3). This template uses the sophisticated functions only available on Windows versions of the spreadsheet program and therefore may not work properly with older versions of the software.

The template has five functional areas:

1) Factor Details - This area contains information related to the factors used in the analysis process. The factor identification number, factor description and reduced survey data (i.e., statistical results based on the collective consensus of industry experts) are presented. This information is used to graphically define the model. This area represents the knowledge base of the system and can be updated over time as required.

2) Scenario Details - This is the data input area of the template. Case scenario information, translated into numeric ratings, is keyed into the template in this area. An algorithm is used to manipulate this numeric data into a final actual rating (ACT RATE) for each factor. The actual ratings are automatically transposed onto the graphic component of model.

3) Model Details - This area basically represents the first two functional areas in graphical form. Graph # 1 is the actual Success Potential. Graph # 2 is the Factor Sensitivity. Both of these graphs are dynamically linked to the data in the first two functional areas. Any updates to the factors or to the case scenario will be automatically updated on the graphs. This area

represents the inference engine of the model.

4) Action Details - This area automatically provides recommendations for actions based on the comparison of the case scenario results (functional area 2) with those of the knowledge base (functional area 1). This area represents the advisor part of the model.

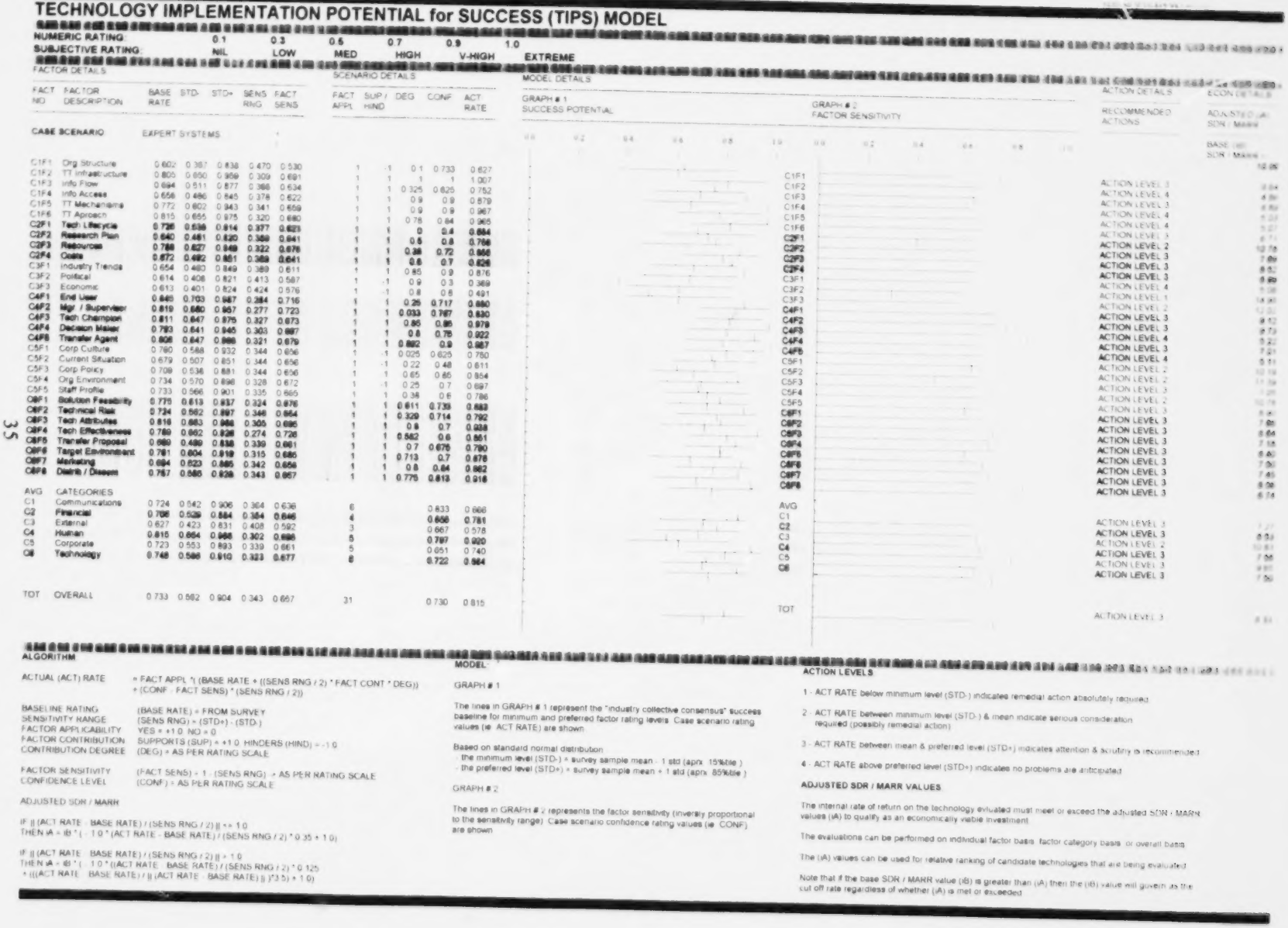
5) Economic Details - This area automatically provides a recommended internal rate of return values that should be used in an economic (benefit-cost) evaluation. This area also represents the advisor part of the model.

This template is in essence the TIPS Model. This model is part of the overall TIPS System proposed for technology implementation assessment.

Figure 2 shows the base perspective of the template where all the factors are depicted in category groupings. Figures 8 through 11 in Appendix A.6 show the template in its entirety from four different perspectives (explained in the next section). The perspectives are based on the Expert System case scenario.

Refer to Appendix A.3 for more detailed template user documentation.

FIGURE 2 BASE PERSPECTIVE OF TEMPLATE AND TIPS MODEL



TECHNOLOGY IMPLEMENTATION POTENTIAL for SUCCESS (TIPS) MODEL

NUMERIC RATING: 0.1 0.3 0.5 0.7 0.9 1.0
SUBJECTIVE RATING: NIL LOW MED HIGH V-HIGH EXTREME

FACTOR DETAILS

FACT NO	FACTOR DESCRIPTION	BASE RATE	STD-	STD+	SENS RNG	FACT SENS
CASE SCENARIO	EXPERT SYSTEMS					
C1F1	Org Structure	0.602	0.387	0.838	0.470	0.630
C1F2	IT Infrastructure	0.805	0.650	0.959	0.309	0.691
C1F3	Info Flow	0.694	0.511	0.877	0.366	0.634
C1F4	Info Access	0.658	0.486	0.845	0.378	0.622
C1F5	IT Mechanisms	0.772	0.602	0.943	0.341	0.659
C1F6	IT Aproach	0.815	0.655	0.975	0.320	0.680
C2F1	Tech Lifecycle	0.726	0.536	0.914	0.377	0.623
C2F2	Research Plan	0.640	0.461	0.820	0.359	0.641
C2F3	Resources	0.788	0.627	0.949	0.322	0.678
C2F4	Costs	0.672	0.492	0.851	0.359	0.641
C3F1	Industry Trends	0.654	0.480	0.849	0.369	0.611
C3F2	Political	0.614	0.408	0.821	0.413	0.587
C3F3	Economic	0.613	0.401	0.824	0.424	0.576
C4F1	End User	0.845	0.703	0.987	0.284	0.716
C4F2	Mgr / Supervisor	0.819	0.680	0.957	0.277	0.723
C4F3	Tech Champion	0.811	0.647	0.975	0.327	0.673
C4F4	Decision Maker	0.793	0.641	0.945	0.303	0.697
C4F5	Transfer Agent	0.808	0.647	0.968	0.321	0.679
C5F1	Corp Culture	0.760	0.588	0.932	0.344	0.656
C5F2	Current Situation	0.679	0.507	0.851	0.344	0.656
C5F3	Corp Policy	0.709	0.536	0.881	0.344	0.656
C5F4	Org Environment	0.734	0.570	0.898	0.328	0.672
C5F5	Staff Profile	0.733	0.566	0.901	0.335	0.665
C6F1	Solution Feasibility	0.775	0.613	0.937	0.324	0.676
C6F2	Technical Risk	0.734	0.582	0.887	0.305	0.695
C6F3	Tech Attributes	0.818	0.683	0.966	0.305	0.695
C6F4	Tech Effectiveness	0.769	0.662	0.926	0.274	0.726
C6F5	Transfer Proposal	0.669	0.489	0.838	0.339	0.661
C6F6	Target Environment	0.761	0.604	0.918	0.315	0.685
C6F7	Marketing	0.684	0.523	0.885	0.342	0.658
C6F8	Distrib / Dissem	0.767	0.585	0.928	0.343	0.657
AVG	CATEGORIES					
C1	Communications	0.724	0.542	0.906	0.364	0.636
C2	Financial	0.706	0.529	0.884	0.354	0.646
C3	External	0.627	0.423	0.831	0.408	0.592
C4	Human	0.815	0.664	0.966	0.302	0.698
C5	Corporate	0.723	0.553	0.893	0.339	0.661
C6	Technology	0.748	0.596	0.910	0.323	0.677
TOT	OVERALL	0.733	0.582	0.904	0.343	0.657

SCENARIO DETAILS

FACT APPL	SUP / HIND	DEG	CONF	ACT RATE
1	-1	0.1	0.733	0.627
1	1	1	1	1.007
1	1	0.325	0.625	0.752
1	1	0.9	0.9	0.879
1	1	0.9	0.9	0.967
1	1	0.78	0.84	0.965
1	1	0	0.4	0.684
1	1	0.5	0.8	0.768
1	1	0.38	0.72	0.856
1	1	0.6	0.7	0.826
1	1	0.85	0.9	0.876
1	-1	0.9	0.3	0.369
1	-1	0.8	0.6	0.491
1	1	0.25	0.717	0.860
1	1	0.033	0.767	0.830
1	1	0.85	0.85	0.979
1	1	0.8	0.75	0.922
1	1	0.892	0.9	0.987
1	-1	0.025	0.625	0.760
1	-1	0.22	0.48	0.611
1	1	0.65	0.85	0.954
1	-1	0.25	0.7	0.697
1	1	0.38	0.6	0.786
1	1	0.611	0.733	0.883
1	1	0.329	0.714	0.792
1	1	0.8	0.7	0.938
1	1	0.562	0.6	0.861
1	1	0.7	0.675	0.790
1	1	0.713	0.7	0.878
1	1	0.8	0.64	0.962
1	1	0.775	0.813	0.918
6			0.833	0.666
4			0.656	0.781
3			0.667	0.578
5			0.797	0.920
5			0.651	0.740
8			0.722	0.864
31			0.730	0.815

MODEL DETAILS

GRAPH # 1
SUCCESS POTENTIAL

GRAPH # 2
FACTOR SENSITIVITY

ACTION DETAILS

RECOMMENDED ACTIONS	ADJUSTED SDR / MARR
	BASE SDR / MARR
ACTION LEVEL 3	
ACTION LEVEL 4	
ACTION LEVEL 3	
ACTION LEVEL 4	
ACTION LEVEL 4	
ACTION LEVEL 3	
ACTION LEVEL 2	
ACTION LEVEL 3	
ACTION LEVEL 3	
ACTION LEVEL 3	
ACTION LEVEL 4	
ACTION LEVEL 1	
ACTION LEVEL 2	
ACTION LEVEL 3	
ACTION LEVEL 3	
ACTION LEVEL 4	
ACTION LEVEL 3	
ACTION LEVEL 4	
ACTION LEVEL 2	
ACTION LEVEL 2	
ACTION LEVEL 3	
ACTION LEVEL 2	
ACTION LEVEL 3	
ACTION LEVEL 3	
ACTION LEVEL 3	
ACTION LEVEL 3	
ACTION LEVEL 3	
ACTION LEVEL 3	
ACTION LEVEL 3	
ACTION LEVEL 3	
ACTION LEVEL 3	
ACTION LEVEL 3	
ACTION LEVEL 3	
ACTION LEVEL 3	

ALGORITHM

ACTUAL (ACT) RATE = FACT APPL * ((BASE RATE + ((SENS RNG / 2) * FACT CONT * DEG)) + (CONF - FACT SENS) * (SENS RNG / 2))

BASELINE RATING (BASE RATE) = FROM SURVEY
SENSITIVITY RANGE (SENS RNG) = (STD+) - (STD-)
FACTOR APPLICABILITY YES = +1.0 NO = 0
FACTOR CONTRIBUTION SUPPORTS (SUP) = +1.0 HINDERS (HIND) = -1.0
CONTRIBUTION DEGREE (DEG) = AS PER RATING SCALE

FACTOR SENSITIVITY (FACT SENS) = 1 - (SENS RNG) = AS PER RATING SCALE
CONFIDENCE LEVEL (CONF) = AS PER RATING SCALE

ADJUSTED SDR / MARR

IF || (ACT RATE - BASE RATE) / (SENS RNG / 2) || <= 1.0
THEN iA = iB * (- 1.0 * (ACT RATE - BASE RATE) / (SENS RNG / 2) * 0.35 + 1.0)

IF || (ACT RATE - BASE RATE) / (SENS RNG / 2) || > 1.0
THEN iA = iB * (- 1.0 * ((ACT RATE - BASE RATE) / (SENS RNG / 2) * 0.125 * (((ACT RATE - BASE RATE) / || (ACT RATE - BASE RATE) ||)^3.5) + 1.0)

MODEL

GRAPH # 1

The lines in GRAPH # 1 represent the "industry collective consensus" success baseline for minimum and preferred factor rating levels. Case scenario rating values (ie. ACT RATE) are shown.

Based on standard normal distribution
- the minimum level (STD-) = survey sample mean - 1 std (aprx. 15%tile)
- the preferred level (STD+) = survey sample mean + 1 std (aprx. 85%tile)

GRAPH # 2

The lines in GRAPH # 2 represents the factor sensitivity (inversely proportional to the sensitivity range). Case scenario confidence rating values (ie. CONF) are shown.

ACTION LEVELS

1 - ACT RATE below minimum level (STD-) indicates remedial action absolutely required.

2 - ACT RATE between minimum level (STD-) & mean indicate serious consideration required (possibly remedial action).

3 - ACT RATE between mean & preferred level (STD+) indicates attention & scrutiny is recommended.

4 - ACT RATE above preferred level (STD+) indicates no problems are anticipated.

ADJUSTED SDR / MARR VALUES

The internal rate of return on the technology evluated must meet or exceed the adjusted SDR / MARR values (iA) to qualify as an economically viable investment.

The evaluations can be performed on individual factor basis, factor category basis, or overall basis.

The (iA) values can be used for relative ranking of candidate technologies that are being evaluated.

Note that if the base SDR / MARR value (iB) is greater than (iA) then the (iB) value will govern as the cut off rate regardless of whether (iA) is met or exceeded.

3.3.3 MODEL DESCRIPTION

3.3.3.1 Structure

The TIPS Model is represented in numeric and graphical formats. It presents information on the survey results (i.e., the baseline) as well as the results of a particular case scenario. The information in the template can be manipulated and presented from either the perspective of baseline factor importance or the degree of baseline factor sensitivity. It can also be presented from the perspective of the case scenario factor rating for both success potential and confidence.

The model can also present the information from a birds-eye-view of all factors or in the context of any one of the factor categories (typically useful in closer examination of individual categories, factors and attributes).

3.3.3.2 Working Process

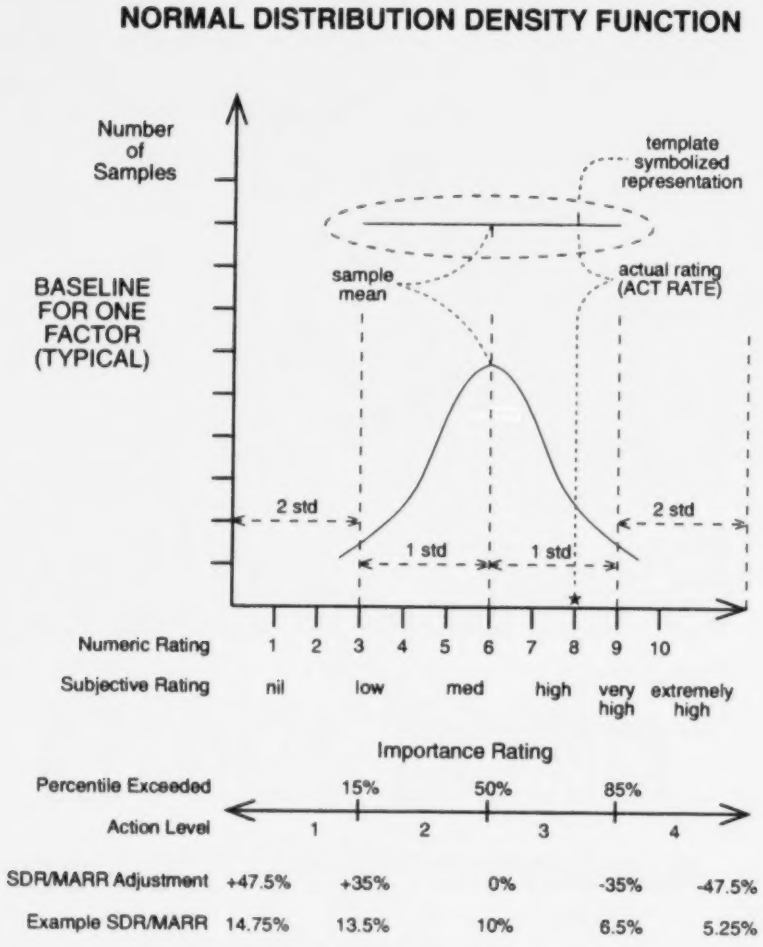
Statistical information regarding the factors is extracted from the survey database and transcribed into the template (via a dynamic link between spreadsheets). A normal distribution is used for establishing the baseline (Hillier). This information is reduced to provide four success potential levels. This is the "collective consensus of industry", or the Industry Consensus Baseline (ICB), against which all case scenarios are assessed. Figure 3 explains the symbolism used in the graphs within the template and the statistical aspects used for analysis.

Data pertaining to a particular case scenario is input directly into the template. An algorithim calculates a rating for each factor (ACT RATE) that is applicable in the given case scenario. This rating is then compared numerically and graphically to the baseline rating. Depending on the case scenario rating, relative to the baseline rating, an action plan is automatically recommended through a pseudo macro (actually, a conditional formula) within the template.

The template also calculates an overall rating for the baseline and both the case scenario success potential and sensitivity ratings. This information provides a quantified (and hopefully objective) estimate of the success potential of the technology in question.

The TIPS ratings are the final product of the template after all numeric processing is completed. During processing the template and database are dynamically linked together. Upon completion of the processing the template spreadsheet is delinked from the database before final perspective selection and report generation.

FIGURE 3 TEMPLATE (TIPS MODEL) SYMBOLISM AND STATISTICS


NORMAL DISTRIBUTION DENSITY FUNCTION
Number of Samples
template symbolized representation
sample mean
actual rating (ACT RATE)
BASELINE FOR ONE FACTOR (TYPICAL)
2 std
2 std
1 std
1 std
Numeric Rating 1 2 3 4 5 6 7 8 9 10
Subjective Rating nil low med high very high extremely high
Importance Rating
Percentile Exceeded 15% 50% 85%
Action Level 1 2 3 4
SDR/MARR Adjustment +47.5% +35% 0% -35% -47.5%
Example SDR/MARR 14.75% 13.5% 10% 6.5% 5.25%

3.3.4 SYSTEM PROCESS & EXECUTION

The factors were established upon completing the literature search. However, they can be updated or improved upon, if necessary, as more information is collected. This process would work in a similar way to that of updating a knowledge base within an expert system. However, the need to update will likely be infrequent and for most practical purposes the knowledge base can be treated as a static part of the system.

The baseline was established through the survey. It constitutes the foundation for the entire system. Without it there is no system. It is static as well. However, it can be treated as an interchangeable module within the system. In other words the baseline used in this application was established within the context of the road transportation industry. In the future it can be replaced with baselines established in other contexts. This facility lends the system to generic application.

The other static part of the system involves the template and the algorithm that drive it. This can be effectively compared to the inference engine of an expert system.

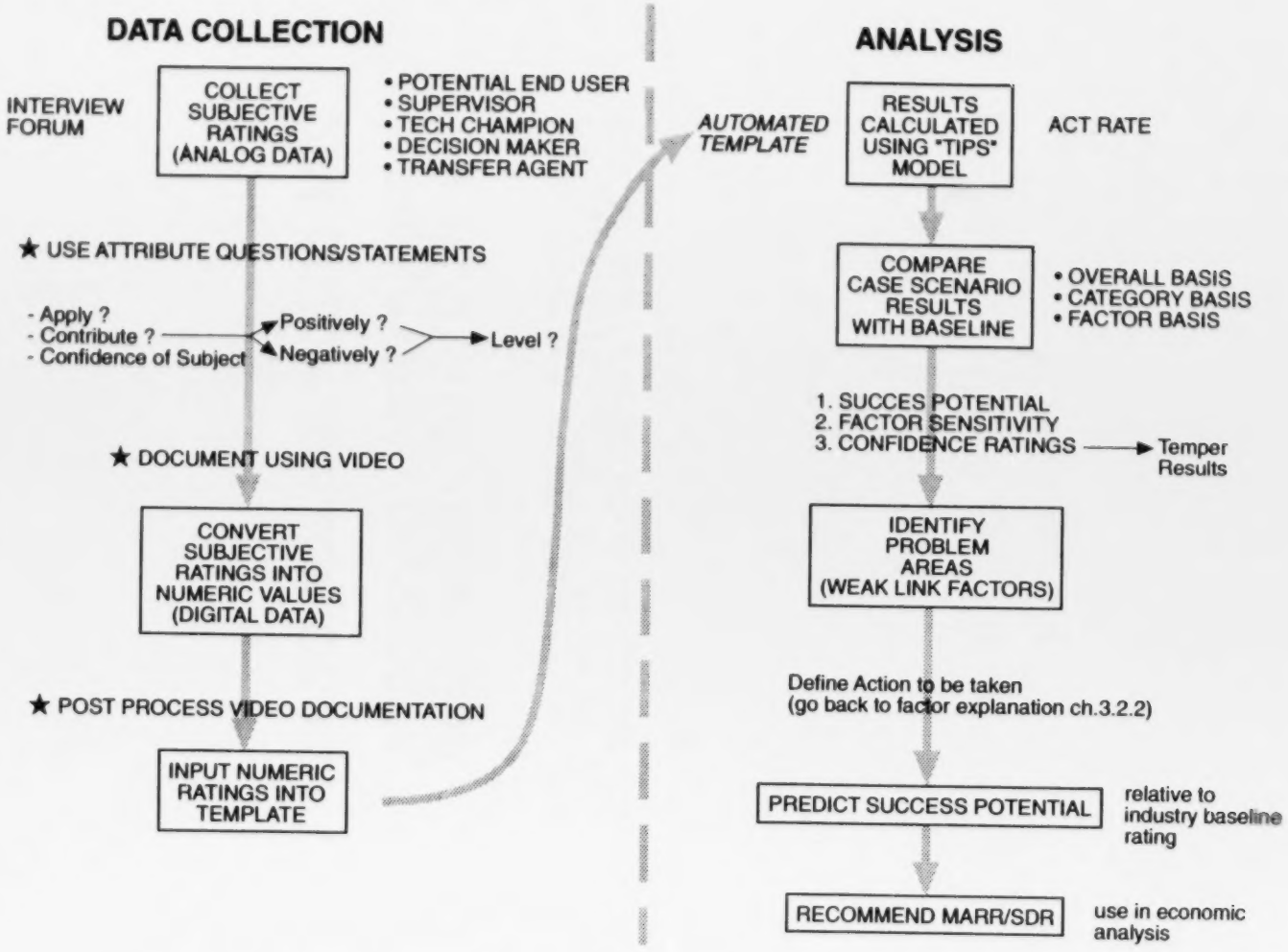
The dynamic part of the system involves case scenario data input and analysis. This is the working memory and user interface of the system. The scenarios will be different in each case, therefore, data collection will be required for each analysis. This process is an important part of the system and good results are dependent on the data that is fed into the system. "Garbage in equals garbage out" truly does apply here. It is critical to properly execute the case scenario data collection process.

Although it had not actually been done as part of the case scenario test, a data extraction process using interviews should involve all parties with a vested interest in the technology implementation process. The group of key players would include:

- the potential end user
- the potential end user's superior
- the technology champion
- the final decision maker
- the transfer agent or team (the only group examined in the case scenario test).

Figure 4 depicts the processes employed when using the system for success potential analysis.

FIGURE 4 TIPS SYSTEM PROCESS FLOW CHART



Different approaches were examined in case scenario data collection with varying degrees of success. The best way to describe this process is to apply the terms analog and digital to the methods evaluated.

The TIPS system requires the user (i.e., any individual as identified in section 3.3.1.2) to collect subjective ratings during interviews with key players and to convert them into numeric data. Throughout all data collection aspects of this research work the same subjective rating scale has been used. This scale has a decimal based numeric scale as a counter part. The process of extracting subjective data, say through an interview forum, involves translating that subjective data (or analog data) into numeric data points (or digital data) so that they can be manipulated by a mathematical algorithm. This cannot be done effectively in real time, neither by the individual being interviewed nor by the individual performing the interview. The best method for capturing and translating this information involves video recording the interview. The responses to questions and statements related to factors and their attributes are documented and can be post processed more effectively at a later time. Tape recording the interview is an option, but, the body language (which conveys nonverbal information and innuendo) is not captured, thus, making the estimation of confidence more difficult.

The post processing involves reviewing the video document (repeatedly if necessary - a luxury not afforded in real time) and one by one numerically rating each factor on the basis of the following criteria:

1) Does the factor/attribute apply?
   Yes = +1.0, No = 0.0

2) Does the factor/attribute contribute in a positive or a negative manner to the final outcome?
   Positive = +1.0, Negative = -1.0

3) What is the level of the contribution?
   Nil = 0.1, Low = 0.3, Medium = 0.5, High = 0.7, Very-high = 0.9, Extreme = 1.0 (intermediate ratings also possible)

4) Level of confidence exhibited by subject when discussing factor related issues.
   Nil = 0.1, Low = 0.3, Medium = 0.5, High = 0.7, Very-high = 0.9, Extreme = 1.0 (intermediate ratings also possible)

3.3.4.1 The Analysis

Once the data input is complete, the template automatically initiates the calculations and produces the results which are used in the analysis.

The analysis includes the following:

1) comparing actual case scenario factor ratings with the industry consensus baseline factor ratings to determine the influence of the particular factor on the success potential;

2) comparing the case scenario confidence ratings against the baseline factor sensitivity ratings to determine the degree of confidence in the predicted success potential.

A specific example of the analysis of one factor is presented in Figure 7 in section 4.3.1.4. A global view of the analysis of all factors is shown in Figure 2 in section 3.3.2.

3.3.4.1.1 Success Potential

The baseline mean values for each factor are used as a starting point for determining the case scenario actual ratings. In other words, it is assumed that each factor for a case scenario meets or exceeds 50% of the ratings determined by the collective consensus of industry experts. Factored into the mathematical algorithm, which will determine the actual rating, are:

- this baseline rating;
- whether a particular factor applies to the case scenario;
- whether it will contribute in a positive or negative manner to the final outcome;
- the degree of this contribution. Refer to Figure 2 for details.

The baseline also establishes three levels (four zones) for comparing actual case scenario ratings. They are the mean level as mentioned above (or average industry rating), the preferred level (the mean plus one standard deviation which is roughly equivalent to the 85th percentile) and, the minimum level (the mean minus one standard deviation which is roughly equivalent to the 15th percentile). These levels define which of the four recommended actions should be considered for each factor, factor category and overall case scenario. These actions include:

Action Level 1 - recommending that remedial action be initiated to improve the factor rating before implementation proceeds if the actual rating is below the

minimum baseline level;

Action Level 2 - recommending serious consideration which may include remedial action if the actual rating is between the minimum and the mean levels;

Action Level 3 - recommending attention and scrutiny of the factor, factor category or overall scenario if the actual rating is between the mean and the preferred levels;

Action Level 4 - suggesting that no problems are anticipated if the actual rating is above the preferred level.

A pragmatic approach was taken to establishing the action level zones. Since a normal distribution density function (refer back to Figure 3 in section 3.3.3.2) was used to represent the baseline for each factor, it naturally followed that well understood and accepted parameters, such as the mean and standard deviation, be used to define the model. Hence, the zone boundaries were chosen at the mean and at plus and minus one standard deviation because it facilitated:

- simplicity in visualizing and understanding the model;
- close representation of real case observations (i.e., minus one standard deviation represents roughly the 15th percentile where approximately fifteen percent of cases would rate below that observation, similarily for the mean (fifty percent) and plus one standard deviation (eighty five percent));
- simplified calculations within the model.

The action levels are used to temper the potential rating that was calculated. They allow for the identification of possible problem areas that may not be as obvious as those factors rated with nil or low success potential ratings. For example even though a particular factor rating may be high it may fall below the minimum baseline level because the mean baseline is very high. This may suggest that the factor could be a possible weak link even though the overall rating for the case scenario may lean toward a relatively high potential for success. What this also means then, is that even though an overall case scenario potential for success may be rated high, each factor category and each factor should be reviewed on its own merits. These " weak link" factors (which also include the low rated factors) are the key driving factors and are most important to consider during the analysis as they are critical to predicting the final outcome.

3.3.4.1.2 Factor Sensitivity and Confidence

The sensitivity range, which is determined by calculating the difference between the preferred level rating and the minimum level rating, indicates two things:

- the degree of outcome sensitivity for each factor (i.e., a narrow range may suggest that a relatively minor remedial action may be required to change the potential outcome from a negative to a positive one - the converse is true as well).

- the level of confidence in the baseline rating (i.e., the larger the range the less consensus among the industry experts, thus suggesting that the baseline itself may not be very accurate).

The case scenario confidence rating is compared with the factor sensitivity (or industry confidence) rating. If the scenario rating is significantly lower than the industry rating this may suggest another weak link and the factor should be examined more closely.

3.3.4.1.3 Proposed Application to Economic Analysis

In real life situations, whether in the public sector or the private sector, resource rationing is a certainty. The primary resource for consideration is available funding. Rarely, if ever, is there enough funding available to pursue all projects that have demonstrated potential benefits greater than estimated costs. To economically rationalize the choices for which technologies do or do not make the cut, the following is one proposed possible methodology.

For the purpose of illustration we will consider the Discounted Cash Flow method (Noori and Radford, 1990, p266, Hertz, 1964, Sprague and Whittaker, 1986). We will look at the Social Discount Rate (SDR, the rate which represents the opportunity cost to society of resources used in public sector investment projects) or the Minimum Acceptable Rate of Return (MARR, the after tax lower limit of investment acceptability in private sector projects). The proposed method suggests incremental adjustment to each value based on the ratings resulting from the analysis performed using the TIPS model.

The recommended adjustment values are directly proportional to the amount of Actual Rating deviation from the mean of the baseline. They are adjusted upwards if the technology exhibits risk and conversely they are adjusted downwards if they exhibit great success potential. This adjusted value is used as

the cutoff rate for the particular technology being considered.

In other words if the baseline mean is 6 and the standard deviation is 3 and:

- the Actual Rating is 8, then the SDR or MARR values would be adjusted:

  -2/3*35%*MARR or -2/3*35%*SDR

- the Actual Rating is 5, then the SDR or MARR values would be adjusted:

  +1/3*35%MARR or +1/3*35%*SDR

- the Actual Rating is 2, then the SDR or MARR values would be adjusted:

  +(35% + 1/3*12.5%)*MARR or +(35% + 1/3*12.5%)*SDR

The 35% represents the range (of the area within the normal distribution density function) bounded by the mean and one standard deviation. The 12.5% represents the range bounded within one and two standard deviations. It is not anticipated that actual ratings will fall outside two standard deviations, and if they do, the adjustment to SDR or MARR will remain constant from two standard deviations outward. Note that throughout this document the standard deviation values are rounded. Since all aspects of this analysis are estimates, absolute accuracy is not deemed critical.

Two or more technologies can be compared either on an individual factor basis, or factor category basis or overall basis. During this evaluation the SDR or MARR values can be adjusted to reflect the success potential (or inherent risk) for each case scenario. The actual economic analysis (or benefit-cost analysis) should be performed based on calculating the rate of return for each technology. After this is completed, the technologies which exceeded the adjusted SDR or MARR values should be laddered in descending order of rate of return. The base MARR or the available funds would then determine the absolute cutoff rate.

4.0 RESULTS AND OBSERVATIONS

4.1 SURVEY RESPONSES

The survey was one of the most difficult aspects of this research. The objective was to design a comprehensive form that would cover a large amount of information yet would not be onerous for the subjects to complete. To this end, all that the survey respondent was requested to do was provide a numeric rating. All thirty-one factors were listed. They were grouped thematically and had their supporting attributes listed to better define the respective factors.

4.1.1 LEVEL OF RESPONSE

One hundred thirty-one responses were received. This represents 60.1% of the survey sample. The breakdown for responses is as follows:

Group A: 28 responses
Group B: 26 responses
Group C: 30 + 1 rejected
Group D: 9 + 2 rejected
Group E: 5 responses
Group F: 14 + 1 rejected
Group G: 6 responses
Group H: 9 responses

Refer back to section 3.1.2.2 for a description of each group type. Refer to Appendix A.2 for actual survey results.

4.1.2 COMPARISON OF SURVEY SUBGROUPS

Overall, the subgroup ratings varied less than one point from the success potential and factor sensitivity ratings of the total survey sample. At the category level, the ratings varied slightly more and even more so at the individual factor level. This was primarily due to the difference in size of the sample subgroups. However, it is interesting to note that the largest variance was observed on factor C1F1 (Organizational Structure) between subgroups G and H. This is an interesting observation because of the origins of the technology transfer agents (i.e., head offices and field offices within a department of transportation, respectively). In any case the ratings did not vary enough to suggest overly influencing biases within the subgroups.

4.1.3 COMMENTS FROM SURVEY RESPONDENTS

Twenty-six of the repondents provided additional comments. Refer to Appendix A.2 for comment details.

The survey was squeezed into four pages (three of which actually contained the questions). This forced the use of a smaller fonts size, thus, resulting in a number of complaints. Another complaint indicated that the survey was not simple (that each factor warranted substantial thought) and took much longer to complete then the five or ten minutes suggested in the survey instructions.

Other than identifying two additional factors (or potential attributes), those being environmental impact and safety, the additional comments did not offer new insight on the subject of technology implementation.

4.2 SYSTEM / MODEL

4.2.1 THE BASELINE

Upon examining the "transportation" industry consensus baseline, two observations were made:

1) The factor success ratings are clustered around the high rating suggesting that:

- the thirty-one factors that were identified should be considered in order to make a qualified and somewhat confident technology implementation decision;

2) The factor sensitivity range is narrow (i.e., = < 2 rating points) and is clustered around the medium-high rating suggesting:

- that the general consensus of industry experts on technology implementation is good, therefore, supporting confidence in the use of the baseline for case scenario examination;

- that changing the TIPS rating for any subject technology is possible with remedial actions, some times it may be without great effort or drain on resources, and an attempt to do so should be encouraged so to significantly improve the chances for successful implementation.

4.2.2 DATA EVALUATION

The design of the analysis process used in the model attempted to emulate a classical statistical inference for an engineering decision-making process (Ang and Tang, 1975). This involved:

i) observing real world situations

The process involved extracting information from observations made on how technology implementation is executed in large organizations.

ii) collecting data

Information from various sources was consolidated and validated to ensure that the design of the model would be truly representative.

iii) estimating parameters and choosing a representative distribution (the statistical inference in this case is the Gaussian normal probability density function)

Because the data was subjective (heuristically based) absolute accuracies were not critical. The author's objective was to determine general representations. Therefore, simplicity was the key. The appropriate distribution was determined by visual fit and validated. Histograms of survey responses were plotted on a few randomly selected factors. Then the simplest best fit distribution which represented the histogram was adopted. This was done without further statistical examination (i.e., best fit using Chi-Squars, Kolmogorov-Smirnov, etc.) because discrete data points were used (i.e., ratings) rather than floating ranges. The most commonly used distribution, the normal density function, represented the data adequately (except at the tails). There did exist an ever so slight skewness in the occasional histogram. A normal probability paper was constructed for a select number of factors to validate normality.

iv) calculating the probabilities

Calculation of probabilities does not actually apply here as simulation is not part of the process. Determining the potential rather than the probability was the focus. The potential is readily determined by directly comparing the actual rating (ACT RATE), as calculated by the TIPS model, with the normal probability density function representing the

consensus of industry experts. This provides a percentile value.

v) using the results to make a decision.

The model computes results and reports the status of a given case scenario in terms of implementation success potential. It also identifies areas where actions can be taken to improve this potential. The resulting information that the model provides facilitates informed decision making.

4.2.3 COMPARISON TO ANOTHER TECHNOLOGY TRANSFER MODEL

Of all the literature reviewed during this research, only one source provided a definitive technology transfer model (De La Garza and Mitropoulos, 1993, p435) for the implementing of new technology. Coincidentally, the subject of the model was the implementation of Expert Systems in the Architectural-Engineering-Construction (AEC) industry. Figure 5 provides a crude schematic copy of this model. The shaded boxes represent the combination of alternatives for the highest probability for successful implementation of expert systems technology.

The De La Garza model explains the adoption process through alternative/recommended "actions" (equivalent to TIPS attributes) which should be to be taken at each implementation "stage" (equivalent to TIPS factors). The TIPS system (and model) include the considerations presented in the De La Garza model.

4.2.4 MULTI-ATTRIBUTE DECISION ANALYSIS AND UTILITY THEORY

Although there are a number of Multi-Attribute Decision Analysis (MADA) methodologies (Gibson, 1981, Anandilingam and Ollson, 1988, Falkner and Benhajla, 1990, Datta, 1992, Noori), the one most relevant to this problem is the Analytic Hierarchy Process (AHP) (Datta, 1992, Noori). The AHP method is an interactive eliciting decision model which was designed to facilitate effective decision making in unstructured problem-solving environments. This method breaks down a decision problem into three levels and structures it into a hierarchy with the objective at the top level, the criteria at the intermediate levels and the solution alternatives at the lowest level. In this hierarchical structure every element of a given level functions as criterion for all the elements of the level below. The decision process is divided into two parts. The first involves ranking criteria with regards to importance in the final decision. The second involves ranking the set of alternatives against the set of criteria. This ranking process involves extensive use of paired comparisons of elements with respect to their

relative impact on a property they share in common. Matrix manipulation is used for the numerical calculations required to arrive at a result that consists of a relative ranking of the alternatives.

The AHP method is most applicable when there are many technology alternatives to be considered. In this situation, the objective would be to select the best alternative (i.e., the technology with the greatest potential for successful implementation). The criteria would be the TIPS factors and the alternatives would be the different technologies. The results would consist of a ranking order for the technology alternatives.

TIPS provides a potential rating based on a relative percentile scale established by the Industry Consensus Baseline. It does not provide probabilities for failure consequence costs or the success benefit magnitude. However, if these can be determined and if the risk / gamble profile for the decision maker can also be determined, then we have the components required to build utility curves. In this regard, TIPS compliments the Utility Theory (Gibson, 1981, Wolf, 1983) approach by providing another dimension for consideration in a decision analysis process.

Although TIPS can stand on its own for the purpose of an analysis, its effectiveness as a tool can be leveraged if it is incorporated with other well-established methodologies.

FIGURE 5 De La GARZA TECHNOLOGY TRANSFER MODEL

T2 PROCESS PHASES	IDENTIFICATION		EVALUATION			IMPLEMENTATION					
T2 PROCESS STAGES *(TIPS FACTORS)*	RECOGNITION OF FORCES/ OPPORTUNITIES	IDENTIFICATION OF TECHNOLOGY	COMMITMENT OF INITIAL RESOURCES	AQUISITION OF TECHNOLOGY CAPABILITIES	TECHNICAL/ CORPORATE EVALUATION	DECISION ON ADOPTION	TECHNOLOGY DEVELOPMENT AND IMPLEMENTATION				CONFIRMATION OF TECHNOLOGY VALUE
							TYPE OF TECHNOLOGY	SIZE/COST OF TECHNOLOGY	DEVELOPMENT	SOURCE OF FUNDING	
T2 PROCESS ALTERNATIVES *(TIPS ATTRIBUTES)*	POSITIVE ATTITUDE TOWARDS TECHNOLOGY	APPOINTED END USER	ORGANIZATION BUDGET	TRAINING PERSONNEL (EXISTING)	APPOINTED	ESTABLISH NEW BUSINESS LINE	STRATEGY	LARGE/ COMPLEX HIGH COST	IN-HOUSE CENTRAL	CLIENTS	ADDITIONAL REVENUES
	CLIENT NEEDS	SENIOR MANAGEMENT	R&D BUDGET	HIRING PERSONNEL (WITH EXPERIENCE)	TEMPORARY TASK FORCE	PROVIDE NEW SERVICE TO CLIENTS	TACTICAL	SMALL/ SIMPLE LOW COST	IN-HOUSE DIFFUSED	ORGANIZATION BUDGET	IMPROVED IMAGE
	COMPETITORS STRATEGIES	MIDDLE MANAGEMENT	DEPARTMENT BUDGET	OUTSOURCING SERVICES (EXTERNAL CONSULTANT)	EXTERNAL CONSULTANT	PRESERVE ORGANIZATIONAL EXPERTISE			EXTERNAL	DEPARTMENT BUDGET	IMPROVED PRODUCT COST & QUALITY
	PROJECT COMPLEXITY	OTHER TECHNICAL PERSONNEL	END USER RESOURCES			AUTOMATE COMPLEX TASKS				END USER RESOURCES	IMPROVED OPERATIONAL EFFICIENCY
	OPERATION NEEDS		CLIENT			IMPROVE TRAINING					IMPROVED UTILIZATION OF HUMAN ASSETS
COMMENT	DIFFERENT TECHNOLOGIES WILL REQUIRE EMPHASIS ON DIFFERENT COMBINATIONS OF ALTERNATIVES FOR SUCCESSFUL IMPLEMENTATION (i.e. SHADED BOXES)										
LEGEND	*(EQUIVALENT TO TIPS MODEL)* COMBINATION OF ALTERNATIVES FOR HIGHEST PROBABILITY OF SUCCESS FOR IMPLEMENTING EXPERT SYSTEMS TECHNOLOGY (based on De La Garza example) SHOWN SHADED										

4.3 CASE SCENARIO TEST

The test case scenario involved the assessment of Expert System technology implementation within a large public organization. It is noted that the actual implementation of this technology was near completion at the time of this assessment.

In performing the TIPS assessment a retrospective review was initiated for all implementation related events. Once this was completed a prediction was made based on the results of the analysis of all applicable factors. As a final step, a comparison was made to the actual results of the implementation effort. The following sections provide details on the technology, the organization, the implementation process and the results of the assessment.

4.3.1 The Contemplated Technology

Consideration of Expert Systems was the example used to test the model. Relevant questions in defining this technology include:

> What is an Expert System? What does it do? Who should use this technology? How should it be applied? When and where should it be applied? Why should it be considered as a solution? (Zacharia, June 1990, Zacharia, September 1990, Zacharia, 1992)

An expert system is a knowledge intensive computer program that emulates an expert when solving a problem. An expert system like any other computer program is a tool designed to aid the user. The sole intent of an expert system is to provide advice. The output generated by an expert system is not a substitute for engineering judgement. They can also be defined as an automated consulting system designed to give expert advice within a particular domain. Conventional programs reduce a problem into mathematical terms that can be manipulated by an algorithm. An expert system deals with the graphical and verbal aspects of knowledge which are manipulated by logical inferences. Simply put, expert systems are sophisticated computer programs which manipulate knowledge to solve well-defined problems in a manner similar to the way a human expert would.

The term "heuristics" is used frequently in the description of expert systems. Heuristics can be defined as rules of thumb. A rule of thumb does not always guarantee the correct answer; it only increases the chances of finding a possible answer. Heuristics represent probable knowledge and play a major part in an

expert's description of real world problems. An example of a rule of thumb would be, "If your engine stopped suddenly while driving it is probably out of fuel". Knowing the rule of thumb does not mean it is the correct answer but it is a probable answer. There could be problems with the engine or problems in the electrical system instead of it being out of fuel. Heuristics depend on the knowledge of the specific situation and they are usually acquired from experience.

There are three major roles that are important in expert system development, the user, the expert and the knowledge engineer. The user is defined as the end user of the expert system, the person that the expert system was developed for. The expert is the person who, through years of training and experience has become extremely proficient at problem solving in a particular domain. The knowledge engineer is the person who interviews the expert and actually builds the expert system.

There are three major parts to an expert system, a knowledge base, working memory and an inference engine. For the purpose of analysis it is convenient to consider these components as different areas in the memory of a computer.

The knowledge base contains static information on the problem and how to solve the problem. It is here that the expert's heuristic knowledge or rules of thumb reside. The information in the knowledge base is static only during the analysis while the expert system is actually being used. An advantage of expert systems over conventional computer programs is the ease in updating information in the knowledge base. Therefore, it is always possible to keep the knowledge base as current as necessary.

The working memory is used for dynamic information. It is here that intermediate conclusions are stored while the expert system is running. Any data that is entered by the user during an analysis is also stored in the working memory.

The inference engine takes the heuristic knowledge in the knowledge base and applies it to the information in the working memory. The inference engine uses either forward chaining or backward chaining or a combination of both methods. Forward chaining uses the rules to determine what can be concluded from the given data. Backward chaining starts with a given goal and tries to answer the question, "Can we conclude this goal from the available information?".

The following is a comparison of the advantages and disadvantages of human experts to expert systems.

Human experts are creative and adapt to changing conditions. Expert systems have not yet become sophisticated enough to be able to learn on their own. Research is being done in this area, but, presently expert systems are incapable of changing their strategies to reorganize and synthesize new knowledge.

Human experts can access sensory data directly. Since expert systems have to convert sensory data to symbolic input, information such as taste, or texture can get lost in the translation.

Human experts tend to have a broad focus. They can examine many different sides of the problem to enable them to consider the overall picture. Expert systems by their very nature have a narrow focus. They can only consider the main problem and the factors associated with it.

Human experts have intuitive knowledge which the expert system cannot totally contain. There would be too much information to code if all the intuitive knowledge known by the expert was to be coded.

Human expertise is perishable. If the expert does not use his/her expertise, the knowledge can potentially decay. The expert could retire or change jobs. Expert systems on computer disks though are a permanent form of knowledge storage.

Documenting and transferring human expertise is time and labour intensive. Training and teaching new personnel is a major cost in many organizations. Transferring an expert system though, can be achieved by simply copying the program. As end users use expert systems they gain an understanding which speeds up the process of training and transferring human expertise. Once the expert system has been developed it becomes a simple process to extract the code and document the knowledge.

Human experts might make different decisions in identical situations because of emotional factors or perhaps some very subtle rules might have been overlooked. Expert systems, are consistent over the long term. There are no emotional factors to cloud the judgement and all the rules, subtle or otherwise, which are pertinent will be included in the analysis.

Human experts tend to be expensive. If they are unique enough, experts are able to demand and receive good incentives and valuable benefits. Expert systems, though over the long term, are comparatively low cost. Once an expert system is developed, the maintenance cost will be a fraction of the development costs.

To summarize, expert systems should be considered if there is a need to:

- Retain expertise that could be lost through personnel change.
- Duplicate an expert's knowledge in different locations.
- Reduce the expert's work load by solving everything but the most complex problems.
- Provide senior expertise and act as a training device for junior staff.
- Provide consistent designs and evaluations throughout the organization.
- Provide an affordable form of knowledge documentation.

Expert systems should not be considered if:

- The environment of the problem is constantly changing.
- There is a strong need for sensory data.
- The problem is especially broad and cannot be limited to a narrow domain.
- An abundance of intuitive knowledge is required.

4.3.2 The Existing Organization

The subject organization is a provincial government department. It is primarily a technically based one which implies scientifically based decision making processes are used. The caveat to this is that social political considerations can and do override or veto many of these decisions.

This organization is the third largest department in the provincial government. It employs over 2,000 people on a full-time basis and is focused on providing an integrated efficient transportation system which supports the province's social and economic well-being. There are over 155,000 kilometres of highways, of which almost 24,000 are paved, approximately 111,000 are gravelled and over 21,000 are graded or oil-treated.

Over the past ten years the full-time staff component has steadily decreased. After ten years it has been reduced by 33% and the part-time component by 25%. This represents an overall staff reduction of approximately 30%. In parallel with staff reduction there have occurred major reductions in capital construction budgets with a focus shift toward maintaining existing roads rather than constructing new ones. At the same time overall organization expenditures have

been reducing by roughly 10% per annum. Much of the heuristic knowledge that is disappearing is maintenance related.

The province is currently in a period of fiscal restraint. The overall managing philosophy can be described by the statement "doing more with less". However, there is an constantly decreasing resource pool. The organization's staff are facing intense personal pressure as they are expected to perform their jobs with fewer resources while the prospect of job loss (or at least severe change, such as reallocation) looms in their minds. This is creating a condition in which few people have slack time in their jobs (to experiment) nor do they have the inclination to try new things (when mere survival is on their minds). The current trend within the organization is expected to continue for the foreseeable future.

Support functions such as planning, design, contracting and construction administration are primary activities performed at head office in the provincial capital. Much of the organization is decentralized with field offices located throughout the province. These field offices are responsible for the delivery of the department's programs, mainly construction and maintenance of the roadway infrastructure (which also includes bridges and airports). Communications within the organization tend to follow established protocols. Current efforts in improving information access and delivery are starting to slowly chip away at these protocols. However, authority based decision making strictly adheres to the typical pyramid shaped hierarchical flow. The field offices have some autonomy with respect to decision making, but anything of significant fiscal consequence again reverts to the hierarchial protocol.

The structure of the organization is in a state of flux geared toward downsizing. The current situation within the organization is an unstable one. Although this instability should be conducive to change which in turn should be conducive to the introduction of new technology, this is not necessarily the case. As mentioned earlier there is an air of perceived threat among the staff which seems to undermine that excitement that one would expect to be generated by new technology. There are pockets of individuals that are very receptive to new concepts and ideas, and there are many pockets of individuals that are resisting change.

The culture within the organization is complex. It is almost schizophrenic in nature. The complexity arises from the organization's staff profile which includes engineers, technologists, individuals with administrative backgrounds, mechanics, equipment operators, political bureaucrats, lawyers, labourers and systems analysts.

There exist turf wars, between branches and between the head office and the field (the most significant cultural difference). There exists an "us versus them"

mentality. The observations made, supported by feedback received from individuals within the organization, suggest that communications are good in head office, but, they seem to be not so good between head office and the field. Rumours tend to abound in the field because of the isolation from head office. These groups also tend to have very different, sometimes opposing perspectives of the same reality.

There exists a Research and Development (R&D) Branch in head office. The branch has a complement of twelve technical positions (engineers and technologists) and two support positions. The branch evaluates research products related to materials, operational procedures, equipment, safety and environmental impact. New or innovative technologies are a primary component of these products. The research activities are strategically planned on an annual cycle which integrates well into the organizational strategic planning process. In the planning cycle, resource issues and research costs are of primary consideration.

Within the complement of staff within the R&D branch, there are three individuals charged with facilitating the delivery of technologies to the point of adoption. This section of staff is responsible for ensuring the implementation of technology, be it new, innovative or existing (but never tried). On an ongoing basis, the R&D branch staff are actively involved in sixty research initiatives.

The branch is headed by a director who has been part of the organization for fifteen years. In general he is very supportive of new technology and can be considered as an activist when it comes to its' implementation. He is a type of individual who likes to be informed, but retains a high confidence in his staff and encourages his staff's discretion over projects as long as the fundamental objectives are met. He tends to follow policy officially, but where warranted will challenge directives which frustrate the delivery of his branch's mandate. He is well informed with what is happening within the industry and keenly supports the department's participation in industry related research activities outside of the organization. The department executive also support these activities (due mainly to the R&D director's championing efforts).

The technology transfer process employed within this organization can be defined as one in which research findings and development efforts are translated into useful processes, products and programs. The underlying program facilitates a communication link between sources of new technology and targets (recipient end users) that are in need of technological enhancements. "New" technology in this sense refers to any improvement over existing technologies or processes, not necessarily a chronologically recent event.

The staff responsible for technology transfer constitute one of the operational sections (or business subunits) within the R&D branch. This subunit has three

main functions:

- to monitor the external environment for valuable products and technologies;
- to facilitate sharing of innovations development internally within the department (usually used in isolation where as broader application is viable);
- conduct evaluation of advance technologies that may impact the department in the foreseeable future.

This unit defines its' mission as promoting new or improved technologies throughout the organization by means of an active dynamic interaction between the sources of technologies and the potential end users. This is accomplished through mechanisms and communication infrastructures designed to effectively deliver technologies and produce tangible results. This organization has in place a well developed technology transfer process.

It should be noted that research and innovation also occur within other areas of the organization independently of the R&D branch. The technology transfer unit plays a key role here in ensuring the awareness of this research and the results are maintained through out the organization.

4.3.3 Application of the Technology within the Organization

The organization that is contemplating this technology was (and still is) a victim of severe attrition. In other words, the organization is losing much of its knowledge and expertise upon the retirement of its senior engineers. Over the years this knowledge and expertise has been acquired through hands on experiences. Because the matter at hand in most cases was more urgent than the knowledge itself, much of this heuristic knowledge was not documented. What resulted was that the knowledge remained in heuristic form in the minds of the individuals (eventually these individuals became resident experts because they were the sole custodians of the knowledge). Much of the subsequent engineering practice evolved to become dependent on this heuristic knowledge of the resident expert. Now the experts are leaving and so is the knowledge. Hundreds of person years of pertinent knowledge has disappeared.

This new technology was looked upon as a possible solution to encapsulating the expertise of these individuals in a form that could readily be exploited by their successors. Further to that, the expertise could also be duplicated and decentralized (in a sense leveraging its' effectiveness).

It was resolved at the onset that expert system technology was a suitable solution for the identified need within the organization. However, it was not necessarily a solution in every case. There was a point of diminishing returns as well, where although possible, implementation would not serve to improve anything, least of

all the cost effectiveness of the subject operation.

The selection of prototype applications considered the past experience of others, or in other words the technology's history (which incidently was short as the practical application of this technology was in its' infancy). An "infusion strategy" (the term used within the organization) was developed which addressed the technology attributes, its' risk and potential benefit. A detailed plan was established for the development, evaluation and post implementation assessment of the prototype applications. Resource requirements were also highlighted. This plan also included details of custodial handoff of the technology from R&D to those responsible for systems implementation and maintenance after successful seeding of the technology within the organization. The whole process involved close interaction with all stake holders including the potential end-users (on specific application basis).

4.3.4 The Implementation Success Potential Assessment

In an actual situation, the assessment process would involve data collection through interviews of all the key players within the organization involved in the technology implementation. The key players would usually include the potential end user, the end user's supervisor, the technology champion, the final decision maker and the technology transfer agent (of course one individual could take on multiple key player roles). For the purpose of testing the TIPS System with respect to the expert system case scenario, only the technology transfer agent was interviewed.

Sixteen different prototype expert systems were developed. Because of similarities three were chosen for thorough examination, each one best typically representing a low, medium and high implementation success rating. Bits and pieces from all sixteen expert systems were incorporated to better represent the profile of each rating.

Data was extracted from a series of interviews with the technology transfer agent. This agent's role was to act as the project leader for implementing expert system technology within the subject department of transportation. The interviews spanned a period of two weeks. Six hours of video tape recordings were produced. The video taped documentation proved to be a very valuable supplemental resource to the available written documentation on the subject.

The documented data was reviewed several times within the parameters set in the detailed descriptions of each factor. This process involved asking a series of questions and issuing statements to seed discussion. The key in making a valid assessment was in extracting enough information about each factor. The easiest way to do this was through the following simple interview and documentation

review protocol:

- prepare simple basic questions or statements using the W5-H method as a guide for their structure (i.e., who, what, when, where, why and how);

- ask the questions or make the statements (both open-ended) for each attribute that defines the factor; (i.e., to seed the interview candidate with appropriate thoughts) and solicit feedback (comments, opinions, etc.);

- go through as many cycles as necessary (using different questions/statements) to obtain a good understanding of the effect of the attribute;

- make note of all the outstanding issues (especially those which have negative impact);

- rate the attributes and aggregate these ratings to establish a factor rating for degree of influence as well as for confidence;

- transpose these ratings into the TIPS model (template);

- repeat the process for all attributes and factors that apply to the particular case scenario being assessed.

Figure 6 is typical of the process involved. The results of factor/attribute assessments for the expert system case scenario are located in Appendix A.5. Figure 7 provides an example of the results interpretation.

FIGURE 6 EXAMPLE OF FACTOR ASSESSMENT

CATEGORY: Human Factors (C4)
FACTOR: End User (C4F1)

TYPICAL QUESTIONS / STATEMENTS:

CYCLE # 1	1)	WHO are the technology end users within the organization?
	2)	WHAT are their attitude towards new technology and associated changes?
	3)	Are they expecting the technology, and if so, WHEN?
	4)	WHERE can their existing skill sets be applied?
	5)	Do they perceive the technology as a threat or benefit, and WHY?
	6)	HOW do they perceive the technology, as a benefit or a threat?
CYCLE # 2	1)	WHO in the organization will be affected by the technology?
	2)	Do they have an understanding of WHAT the technology is about?
	3)	WHEN will the end users be advised of the new technology?
	4)	WHERE are the potential end users located within the organizational structure?
	5)	WHY do they think the technology will affect their job?
	6)	Are they concerned about HOW the technology may affect their job?
CYCLE # 3	1)	Etc.....
	2)	Etc.....
	3)	Etc.....
...ETC.	...ETC.	

ATTRIBUTE	APPLY? Yes = 1 No = 0	CONTRIB? Support = +1 Hinder = -1	DEGREE (Same rating scale through out TIPS system)	RATING	CONFIDENCE	ISSUE DESCRIPTION
Attitude	1	1	0.7	0.7	0.9	Target pockets of idividuals that support new technology.
Change	1	1	0.6	0.6	0.9	Target pockets of individuals that would be good change agen
Understanding	1	-1	0.3	-0.3	0.7 !	No real understanding of the technlogy.
Skill Sets	1	1	0.3	0.3	0.6	Basic computing skills and technical skills exist.
Perceive Threat	1	-1	0.3	-0.3	0.7 !	Lack of understanding fosters some concern re: job threat.
Perceive Benefit	1	1	0.5	0.5	0.5	Some accept that benefits will acrue from technology adoptio

FACTOR DEGREE RATING 0.250
FACTOR CONFIDENCE RATING = 0.717

FIGURE 7 EXAMPLE OF RESULTS INTERPRETATION

CATEGORY: Corporate Factors (C5)
FACTOR: Currernt Situation (C5F2)

RESULTS: Refer to Figure 2 and Appendix A.5 for details.

ACTUAL RATING:

APPLIES	Yes	
CONTRIBUTION	-0.22	Low Hinder
ACT RATE	0.611	Med-High
PERCENTILE	~35%tile	
CONFIDENCE	0.48	Med
SENSITIVITY	0.656	High
ACTION LEVEL	2	Remedial

ATTRIBUTE:	ISSUE DESCRIPTION:
Priorities	R&D and technological innovation paid little attention by senior management.
Fiscal Situation	Current fiscal situation foster survival mentallity.
Do Nothing Impact	Only tried and true methods being considered. Experimentation not common.

RECOMMENDATION:

"WEAK LINK" FACTOR?	Yes
REMEDIAL ACTION?	Yes
RESOURCE INTENSIVE?	Depends on issues.
SDR/MARR ADJUSTMENT	From base of 10% to 11.39%.

COMMENTS:

The results of this analysis suggest that this factor applies and should be considered in the overall success potential analysis.
The contribution is negative and low.
Even though the actual rating for success potential is medium to high it only exceeds approximatley 35 percent of the collective industry consensus of acceptable rating for this factor.
This suggests that the factor is a "weak link" and is critical to the successful implementation of the technology.
Remedial action is strongly recommended in the areas highlighted under issues.

4.3.5 The TIPS Prediction

The final results of the assessment suggest that the success potential for this case scenario technology is high to very high, with the caveat that some scrutiny of a number of factors is recommended. The External, Financial and Corporate factor categories rate comparatively lower to the other categories and should be reviewed. This result suggests that these categories may host "weak link" factors. On a factor by factor basis, six potential problem areas were identified. Remedial action for these six factors (if possible) is recommended in order to improve the technology implementation success potential (i.e., the technology's TIPS rating):

Technology LifeCycle (rated Action Level 2) - greater effort should be made to perform realistic economic evaluations of contemplated technologies. Currently, this is rarely, if ever, done to strict business standards. This is a factor that can be easily remediated.

Political (rated Action Level 1) - political influence is beyond the control of this organization. The organization may be able to manipulate and stretch policy to some degree to accommodate the technology. This factor is very difficult, if near impossible to remediate.

Economic (rated Action Level 2) - a recessional economy is beyond the control of the organization. The only thing that it could do is an internal reevaluation of business processes. It may require wholesale rethought as to how the organization's business is executed (i.e., possibly through business process reengineering) and may be too complicated of a remedial action to consider for the sake of one particular technology.

Corporate Culture, Current Situation, and Organization Environment (each rated Action Level 2) - are factors that can be remediated if the organization's inertia can be redirected. This would required effort from the top (i.e., executive, senior management) in terms of support through policy change, re-prioritization, etc.. Difficult, but possible to remediate over longer time span.

4.3.6 What Actually Happened

Out of the sixteen prototype experts systems developed during the technology implementation process:

- five have been rated as high levels of success (four implemented and currently in use and one to be implemented in the near future);

- seven have been rated as medium levels of success (five implemented and in use, but experiencing some difficulties and two not implemented yet because of

difficulties);

- four have been rated as low levels of success (none implemented with all having high likelihood of being abandoned).

The Expert System technology implementation process spanned three years. In that time the transfer agent developed an intimate understanding of the technology and its' potential role within the organization. The conclusions reached by him were:

- Expert Systems do not and cannot replace an expert.
- Expert Systems are very useful in developing a model or approach that represents the particular thought process used by an expert in solving problems.
- Expert Systems are very good for training.
- Expert Systems should only try to solve 80% of the problem.
- Full cooperation of the end user, the expert, the programmer and the associated management is necessary to ensure success.
- Some problems are too complex to be solved by Expert Systems.
- Expert Systems should be cost justified in terms of use (i.e., a system that reduces the decision time from four hours to one half hour is not useful if it only has to be done once a year).
- Overall, the implementation effort can be deemed successful as many branches have indicated some interest in continuing to develop new systems for other applications (i.e., the technology had been seeded within the organization).

Upon closer examination of the three typically representative prototypes (i.e., low, medium and high implementation success rating) in terms of deviations from the general assessment the degree of success was directly correlated to:

- the degree of client involvement;
- the degree of forefront investment of resources by the client;
- availability of human resources (critical);
- ability to absorb costs;
- end user's attitude towards the technology;
- the end user's perception of threat versus benefit;
- the supervisor's understanding of the technology;
- the technology champion's power of influence;
- consensus with regards to expert opinion (or the availability of an expert);
- subcultural (specific to a sub area of organization, i.e., field versus head office) attitude toward technology and change;
- degree of patience in realizing results;
- appropriateness of technology application;
- level of programming skill;

- availability of time (human resource issue);
- improvement over current methods;
- visibility of potential benefits.

All other factors were equal among the three typical prototypes and the general assessment.

4.3.7 Prognosis for the Future

The Expert System technology is very much depended on community effects. In other words, its' successful eventual adoption depends on the status of current and future networks of adopters, both internally within the organization, and externally throughout the industry. There currently exists some transient incompatibility because of delays in developing this network (i.e., due to economic, cultural and other factors). Because of this, there exists a real risk of stranding and subsequent failure due to a critical mass of adopters not being achieved.

5.0 CONCLUSION AND RECOMMENDATIONS

5.1 SUMMARY

The TIPS System (which incorporates the TIPS Model and the industry consensus baseline) was developed as methodology for objectively and rationally assessing the technology implementation success potential. Thirty-one factors were identified as important considerations that should be addressed in decisions involving investments in technology. Upon completing the research, that was required for developing this model, it can be concluded that technology implementation decisions are anything but trivial and should not be made intuitively. Upon testing the TIPS System with an actual case scenario involving expert system technology implementation into a large public organization the following additional conclusion were reached:

1) The TIPS System is comprehensive and provides confidence in the rational used in making technology implementation decisions.

2) There still exists some inherent subjectivity in the TIPS System. However, the process does break down the subjectivity (via attributes) into manageable parts. By doing this, the implementor can focus on particular issues that may affect the outcome of the implementation.

3) The TIPS System may not always be practical, especially when dealing with low cost technologies with localized or isolated application. However, the TIPS System becomes a valuable tool when there is a need for capital rationing and the selection of alternative technologies is necessary. The system also becomes a valuable tool when implementation of high cost technologies is contemplated.

4) In real life there are many other intangibles that also need to be considered (i.e., political agendas, the saving of lives, social issues). Value judgements will still have to be made, and it may not always be possible to quantify cash flows, nor will it always be realistic to quantify and classify all the benefits and all the costs (especially in monetary terms). Applying the TIPS System in the context of an overall economic analysis may not be a panacea, however, it does provide objectivity to the implementation rational.

5) Further research and future system improvements should be considered.

5.2 FURTHER RESEARCH & FUTURE SYSTEM IMPROVEMENT

Continuous improvement is always desirable. So is the case with the TIPS System. The following are thoughts for additional work in the field of assessing technology implementation:

* Further testing of the TIPS System involving original survey respondents to refine and validate the methodology.

* Application of the TIPS System to other industrial sectors. The baseline component is interchangeable. This could be a means to test whether the TIPS System is indeed generically applicable.

* Development of protocols for integrating the TIPS methodology with other Multi-Attribute Decision Analysis methodologies and its application to Utility Theory.

* Development of an expert system based advisor module for the TIPS System. This module would continue on with the recommended Action Level and provide detailed directions for the specific remedial actions that should be executed for each respective factor given the current situation of a particular case scenario.

* Neural Networks (NN) (Garrett Jr.) provide a nice method for modelling noisy, and somewhat uncertain or incomplete data or knowledge that will grow and change with time. As more factors and attributes are identified over time and as more case scenarios are examined, it may be prudent to investigate the application of NN theory to revising the TIPS Model.

* Development of a counterpart to the TIPS System for assessing the success potential for deploying new technology into the market (i.e., commercializing or licensing of technology).

* Development of a friendly user interface and shell for the TIPS System. This shell would facilitate easy input/output through assisted data collection, data analysis and results calculation, and report generation. The use of the Microsoft Visual Basic environment for this purpose would be a good candidate and should be investigated.

5.3 EPILOGUE

Implementation of a new technology is very difficult and should not be approached in a haphazard manner. Proper implementation requires planning and control. An integrated approach to technology transfer (Noori and Radford, 1990, p505) suggests a five-step action plan. In each step the objective, required actions, and goals (or anticipated results) are clearly defined. These steps are:

* Initiation and Strategic Planning Phase - which involves identifying those areas of the business where new technology will have the greatest impact;

* Feasibility Study and Justification Phase - which involves examining the characteristics of the available and potential technologies and the target environment;

* System (Technology) Selection/Development Phase - which involves developing an implementation plan which is detailed and unambiguous;

* Implementation Phase - which involves facilitating an environment for smooth implementation of the technology;

* Post Implementation Phase - which involves monitoring, evaluating and the ensuring continuity for subsequent cycles of change.

The TIPS System provides a solid foundation on which to piggyback the above approach. This combined process will improve the analysis of new technology viability and the quality of the decision for its' adoption.

.....

In terms of economic analysis in the public sector, government funds should be invested to promote economic and social objectives in an effective manner, utilizing an efficient allocation of resources among competing programs. This objective requires a systematic approach (Jones and Lockhart, 1990) (i.e., benefit-cost analysis) to the problem of evaluating and selecting individual research projects or technology implementation initiatives.

For proper Benefit/Cost evaluation of any government investment (research based or otherwise) the Discounted Cash Flow method is one method that can be used. The rate of interest used in evaluating alternative public projects, referred to as the social discount rate (SDR), is critical to the accept/reject the decision. It is

essential that public investments use a SDR that is based on sound economic judgement.

In the private sector companies usually use a discount rate based on the investments (research, technology or other) opportunity cost of capital (i.e., the return available in the capital markets for investments of the same risk). In other words, this discount rate is referred to as the minimum attractive rate of return (MARR). The Discounted Cash Flow method is commonly applied in economic analysis.

In either case, most investment justifications also tend to be subject to value judgements and it is often not possible or realistic to quantify all cash flows associated with the investment. An additional problem in using benefit-cost analysis is in identifying what should be classified and quantified as benefits and what as costs. To quantify all factors in terms of a dollar value is also often extremely difficult.

The TIPS System again provides a means for handling some of these intangible issues. As well, the TIPS System provides a means for quantifying the SDR or MARR value and can be considered as one possible method for evaluating investment in new technology in the private and public sectors.

BIBLIOGRAPHY

Anandalingam, G. and C.E. Ollson. *A Multi-Stage Multi-Attribute Decision Model for Project Selection*. European Journal of Operational Research. December 1988. p. 271-283.

Ang, A.H.S. and W.H. Tang. *Probability Concepts in Engineering Planning and Design - Vol 1 - Basic Principles*. John Wiley & Sons, Inc. Copyright 1975.

Betsold, R.J. and M.J. Resnbaum. *The Marketing of New Highway Research Products*. Public Roads. December 1988.

Bunting, P.M. *Conceptualizing Technology Transfer*. Cole, Sherman & Associates. (no other information available)

Burgelman, R.A. and M.A. Maidique. *Strategic Management of Technology and Innovation*. Richard D. Irwin, Inc. Copyright 1988.

Coates, D.E. adapted for *The Targeted - Innovation Process*. Targeted Innovation Facilitator's Guide. Greensboro, NC, Centre for Creative Leadership. 1984.

Datta, V.D. et al. *Multi-Attribute Decision Model Using the Analytic Hierarchy Process for Justification of Manufacturing Systems*. International Journal of Production Economics. 1992. p.227-234.

De La Garza, J.M. and P. Mitropoulos. *Flavours and Mixins of Expert Systems - Technology Transfer Model for AEC Industry*. Journal of Construction Engineering and Management, Vol. 118, No. 3. Copyright September 1993. p. 435-453.

Falkner, C.H. and S. Benhajla. *Multi-Attribute Decision Models in the Justification of CIM SYstems*. The Engineering Economist, Vol. 35 No. 2. Winter 1990. p.91-114.

Federal Highway Administration. *Marketing Highway Technology and Programs*. U.S. Department of Transportation. Publication No.: FHWA-RD-91-010. October 1990.

Federal Highway Administration. *FHWA / OECD - Transportation Technology Transfer* (Video). Produced by Audio Video Film for FHWA & OECD, Orlando, Florida. ~1992.

Fichman and C.F. Kemerer. *Adoption of Software Engineering Process Innovations: The Case of Object Orientation*. Sloan Management Review. Winter 1993.

Filipiak, R.M. *Technology Transfer - The process of Transforming Technology Into a Useful Tool*. Published by R&D Branch - Alberta Transportation and Utilities. May 1990.

Filipiak, R.M. *Proposal for Alberta Transportation and Utilities Awards and Recognition Program*. 1992.

Garrett Jr., J.H. *Neural Networks and Their Application Within Civil Engineering*. Computing in Civil Engineering (publishing date and issue number not available). p. 1155.

Gibson, J.E. *Managing Research and Development*. John Wiley & Sons, Inc. Copyright 1981.

Hertz, D.B. *Risk Analysis in Capital Investment*. Harvard Business Review. January-February 1964.

Hillier, F.S. *The Derivation of Probabilistic Information for the Evaluation of Risky Investments*. Management Science. Vol 9, No 3. April, 1963. p. 443-57.

Jones, G.J.F. and R.A.C Lockhart. *Technology Transfer in a Government Office*. Publication No.: PUB-90-03, Published by the R&D Branch - Ontario Ministry of Ontario.

Katz, R., ed. *Managing Professionals in Innovative Organizations*. Harper Collins Publishers. Copyright 1988.

Kepner, C.H. and B.B Tergoe. *Problem Analysis / Potential Problem Analysis / Decision Analysis* (extracted from The New Rational Manager). Princeton Research Press. Copyright 1981.

Large, D.W. and D.W. Baclay. *"A Marketing Planning Framework for Successful Technology Transfers"*. OPTIMUM - The Journal of Public Sector Management. V23-2. Autumn 1992.

Licensing Executive Society. *Technology Transfer - Licensing Executives Society* (Video). McLeod-Mills & Associates, LTD. for LES. Copyright 1988.

Noori, H. and R.W. Radford. *Readings and cases in the Management of New Technology - An Operations Perspective*. Prentice-Hall, Inc., Copyright 1990.

Noori, H. *Newtech Expert Choice: The Deciaion Support System for New Technology Adoption* (Software Reference Manual). Published by Expert Choice Inc. (Copyright date not available)

Rubough Jr., M.E. *"Technology Transfer: A Random Function"*. Automotive Engineering. July 1993.

Schmitt, R.P. and M.J. Mulroy. and Beimborn, E.A. *The Technology Transfer Primer*. University of Wisconsin. August 1984.

Shrieves, G.M. *"Technology Transfer - American Style"*. Public Roads. Vol. 56, No. 3. December 1992. p.112-119.

Sprague, J.C. and J.D. Whittaker. *Economic Analysis for Engineers and Managers - The Canadian Context*. Prentice-Hall Canada, Inc. Copyright 1986.

Tushman, M.L. and W.L. Moore. *Readings in the Management of Innovation*. 2nd Edition. Harper Business Publishers. Copyright 1988.

Wolf, C. *Risk Management in Cost Engineeering - Application of Utility Theory*. AACE Transactions. 1983. p. D.3.1-D.3.6.

Zacharia, Z. and R. Powers and B. Lasby. *Bridge Paint Expert System User Documentation*. Report No.: ABTR/RD/RR-90/09, published by R&D Branch - Alberta Transportation and Utilities. June 1990.

Zacharia, Z. *Expert System Prototype Development, Applicability and Evaluation*. Report No.: ABTR/RD/RR-90/08, published by R&D Branch - Alberta Transportation and Utilities. September 1990.

Zacharia, Z. *Inexpensive Strategies to Implement Expert Systems in Your Organization*. Report No.: ABTR/RD/RR-92/03, published by R&D Branch - Alberta Transportation and Utilities. September 1992.

Zacharia, Z. and K. Cameron. *Technology Transfer In Alberta Transportation*. ORG.A. 622 paper. Copyright April 8, 1993.

APPENDIX

A.1 SURVEY FORM

A.2 RAW SURVEY RESULTS

A.3 TEMPLATE USER DOCUMENTATION

A.4 TEMPLATE FORMULAS

A.5 CASE SCENARIO RESULTS

A.6 TEMPLATE PERSPECTIVES

A.1 SURVEY FORM

SURVEY NO:_____

TECHNOLOGY TRANSFER SURVEY FORM

Thank you for participating in this survey. The objective of this survey is to gain a better understanding of the factors which influence the technology transfer process (specifically the decision making process related to technology implementation). The survey is simple in that all that you are asked to do is provide numeric responses. It should not take you more than five to ten minutes to complete.

There are a total of 31 factors listed in this survey. They are divided into 6 thematic categories. Under each factor you will find a number of supporting attributes with short descriptions. They have been provided to better define each factor. If you have any comments regarding the factors presented or any ideas for additional factors please provide them either directly on the survey form in the "comments" box or on a separate sheet.

If you have any questions regarding the survey or would like to discuss any technology transfer issues I would be more than happy to do so over the telephone or in person (where practically possible). Please feel free to contact me anytime at 403-422-2750.

Upon completion please return this survey in the pre-addressed and postage paid envelope to the attention of Ray M. Filipiak. Thank you.

PLEASE PRINT NAME:

_____

PLEASE PROVIDE YOUR PHONE NUMBER:

(____)_____

PLEASE PROVIDE YOUR MAILING ADDRESS:

_____
_____
_____
_____
_____
_____
_____
_____
_____
_____

DEFINITION OF NEW TECHNOLOGY:

Any process, methodology, material, instrument or tool (new to an organization) that can improve current ways of performing a task or job (in this case related to any highway / road infrastructure planning, design, construction or maintenance operation). The technology does not necessarily need to be "high tech". It can be a recent innovation or a "not yet tried" existing technology.

COMMUNICATION FACTORS INFLUENCING THE TECHNOLOGY TRANSFER PROCESS

The following communications related factors have been identified as influencial to the technology transfer process.
Review each factor and its' supporting attributes and provide the most appropriate numeric rating in response to the question.

IMPORTANCE LEVEL
How important do you think this factor is in assessing the success potential for implementing new technology?

NUMERIC RATING:	1	3	5	7	9	10	
SUBJECTIVE RATING:	**NIL**	**LOW**	**MEDIUM**	**HIGH**	**V HIGH**	**EXTREME**	
ORGANIZATION STRUCTURE							
Decentralization	Degree of decentralization of decision making authorities.						____
Georgraphics	Degree of geographic disbursement of corporate offices.						
Hierarchy	Degree of hierarchial nesting of authorities / decision makers.						
TECHNOLOGY TRANSFER INFRASTRUCTURE							
Communication Channels	Existance of various communication channels within and outside of the organization.						____
Transfer Team / Agent	Existance of staff with a technology transfer mandate.						
Transfer Mechanisms	Existance of mechanisms designed to facilitate effective technology transfer.						
Process	Existance of technology transfer process within the organization.						
INFORMATION FLOW							
Communication Protocol	Degree of adherence to hierarchial communication channels.						____
Industry Interface	Existance of interface to industry and external networks.						
Internal Network	Existance of independent network to facilitate technology transfer communications.						
External Network	Existance of network outside of company to facilitate technology transfer communications.						
INFORMATION ACCESS							
Electronic BBS	Existance of a bulletin board or electronic communication facilities.						____
Query Response	Existance of facilities for easy access to information by all organization staff.						
Library Services	Existance of library services (ie. searches, research database access, etc.).						
TECHNOLOGY TRANSFER MECHANISMS							
Needs Establishment	Existance of mechanism for determining technological needs.						____
Current Process	Degree of understanding of existing processes re: integration new technology.						
Search & Capture	Existance of mechanism for interrogating industry / market for technological solutions.						
Adaptation & Translation	Existance of mechanism for adapting & translating highly technical information.						
Test & Evaluation	Existance of mechanism for testing and evaluating new technology.						
Packaging	Existance of mechanism for preparing information for distribution.						
Dissemination	Existance of mechanism for targeting and delivery of packaged information.						
Media Production	Existance of facilities for packaging information in different formats (target specific).						
TECHNOLOGY TRANSFER APPROACH							
Personal Contact	Degree of face to face interaction employed in the process.						____
Information Packaging	Conciseness and clearity of information.						
Client Involvement	Degree of involvement of client in the development and evaluation process.						
Target Identification	Methodology for identifying audience for implementation.						
Pull vs Push Approach	Type of approach used in process (ie. demand / needs driven = pull).						

FINANCIAL FACTORS INFLUENCING THE TECHNOLOGY TRANSFER PROCESS

The following financially related factors have been identified as influencial to the technology transfer process.
Review each factor and its' supporting attributes and provide the most appropriate numeric rating in response to the question.

IMPORTANCE LEVEL
How important do you think this factor is in assessing the success potential for implementing new technology?

NUMERIC RATING:	1	3	5	7	9	10	
SUBJECTIVE RATING:	**NIL**	**LOW**	**MEDIUM**	**HIGH**	**V-HIGH**	**EXTREME**	
PRODUCT (TECHNOLOGY) LIFECYCLE							
Payback	Degree of significant payback and time to payback.						____
Justification	Degree of returns on investment.						
RESEARCH PLAN							
Organization Strategy	Research as part of overall organization fiscal planning.						____
Research Strategy	Level of research funding planned for.						
Resource Commitment	Level of fiscal, human and other resources commitments.						
RESOURCES							
Human Resources	Availability of human resources when required.						____
Financial Resources	Availability of fiscal resources when required.						
Capital Funding	Availability of required front end funds.						
User Assistance	Availibility of resources for providing assistance to user.						
External Resources	Availability of resources through other sources (ie. cooperative ventures).						
COSTS							
Proof of Concept	Ability to determine costs for developing a proof of concept.						____
Cost to Prototype	Ability to determine costs for prototyping.						
Cost Absorbtion	Ability to absorb costs associated with preliminary development.						

EXTERNAL FACTORS INFLUENCING THE TECHNOLOGY TRANSFER PROCESS

The following external factors have been identified as influencial to the technology transfer process.
Review each factor and its' supporting attributes and provide the most appropriate numeric rating in response to the question.

IMPORTANCE LEVEL
How important do you think this factor is in assessing the success potential for implementing new technology?

NUMERIC RATING:	1	3	5	7	9	10	
SUBJECTIVE RATING:	**NIL**	**LOW**	**MEDIUM**	**HIGH**	**V HIGH**	**EXTREME**	
INDUSTRY TRENDS & DEVELOPMENTS							
Effort Duplication	Avoidance of duplication of effort.						____
Cooperative Alliances	Cooprative alliance with other organizations (leveraging resources).						
Competition	Market driven competition within the industry.						
Technology Development	State-of-the-art.						
POLITICAL							
Government Regulation	Degree of imposed government regulations (ie. environmental impact).						____
Government Stability	Effects due to political situation of the current government.						
Gov't vs Private	Type of organization.						
Gov't Fiscal Situation	Current government fiscal situation.						
Taxes and Legislation	Current government philosophy towards new technology.						
ECONOMIC							
Shrinking Economy	Effects due to a recessionary economic situation.						____
Growing Economy	Effects due to an inflationary economic situation.						
Cost of Money	Current cost of financing.						

HUMAN FACTORS INFLUENCING THE TECHNOLOGY TRANSFER PROCESS

The following human related factors have been identified as influencial to the technology transfer process.
Review each factor and its' supporting attributes and provide the most appropriate numeric rating in response to the question.

IMPORTANCE LEVEL
How important do you think this factor is in assessing the success potential for implementing new technology?

NUMERIC RATING:	1	3	5	7	9	10
SUBJECTIVE RATING:	NIL	LOW	MEDIUM	HIGH	V HIGH	EXTREME

END USER	
Attitude	General positiveness of attitude towards new technology.
Change	General positiveness towards change.
Understanding	General understanding of new technology.
Skill Sets	Strength of existing applicable skills.
Perception of Threat	Degree of threat to job, power or status.
Perception of Benefit	Degree of perceived personal benefit.
MANAGER / SUPERVISOR (OF THE END USER)	
Attitude	General positiveness of attitude towards new technology.
Understanding	General understanding of the new technology.
Support	Support for investing resources towards implementation of new technology.
TECHNOLOGY CHAMPION	
Attitude	General positiveness of attitude towards new technology.
Influence	Potential for influencing outcome.
DECISION MAKER	
Understanding	General understanding of the new technology.
Support	Support for investing resources towards implementation of new technology.
Benefits	Belief that benefits will accrue from implementation of new technology.
Influence	Potential for influencing outcome.
TRANSFER TEAM / AGENT ATTRIBUTES	
Intelligents	Ability to exhibit intelligents without being intellectual.
General Competence	Level of general competence.
Technical Competence	Level of technical competence - expertise.
Independence	Ability to plan and execute actions independently.
Team Play	Ability to work in a teamship environment with individuals with diverse backgrounds.
Leadership	Ability to lead a team of individuals with diverse backgrounds.
Persistence	Ability to persevere through implementation barriers and resistance to change.
Creativity	Ability to develop new strategies for implemention of new technology.
Credibility	Degree of credibility in the eyes of end user.
Commitment	Level of commitment to a technology transfer initiative.
Articulate	Ability to articulate between information source groups and user groups.
Business Sense	Level of business sense and empathy.
People Skills	Ability to work with people of diverse backgrounds.

CORPORATE FACTORS INFLUENCING THE TECHNOLOGY TRANSFER PROCESS

The following corporate related factors have been identified as influencial to the technology transfer process.
Review each factor and its' supporting attributes and provide the most appropriate numeric rating in response to the question.

IMPORTANCE LEVEL
How important do you think this factor is in assessing the success potential for implementing new technology?

NUMERIC RATING:	1	3	5	7	9	10
SUBJECTIVE RATING:	NIL	LOW	MEDIUM	HIGH	V-HIGH	EXTREME

CORPORATE CULTURE	
Reward Systems	Existence of rewards programs to incite innovation.
Corporate Philosophy	Corporate philosophy towards technology, innovation and change.
Executive Support	Backing from highest authorities and decision makers.
Challenge Old Paradigms	Organizational approach to change (proactive vs reactive).
Challenge Problems	Organizational approach to solving problems.
Management Philosophy	Overall management attitude towards new technology.
Corporate Image	Organization self image and reputation within the industry.
Barriers	Organization approach towards removing barriers (ie. outdated policy, etc.).
Allowed Dreaming	Corporate philosophy towards creativity.
CURRENT CORPORATE SITUATION	
Priorities & Urgency	Existing needs, level of importance and available resources.
Fiscal Situation	Current financial state of the organization.
Do Nothing Impact	Impact to organization when a problem is ignored.
External Solutions	Better solutions available outside of the organization.
Organizational Expertise	Availibility of internal expertise vs. outsourcing for solutions.
CORPORATE POLICY	
Tech Transfer Mandate	Existance of a corporate technology transfer mandate.
Organization Mandate	Technology transfer mandate supports organizational mandate.
Technology Policy	Technological innovation is emphasized in corporate policy.
Support Mechanisms	Existance of support mechanisms to execute technology transfer.
ORGANIZATIONAL ENVIRONMENT	
Idea Receptiveness	Degree of receptiveness towards ideas generated outside of the organization.
Crowded R&D Agenda	R&D agenda requiring rationing of resources.
Excitement Generation	Degree of excitement generated from new technologies.
Experiment Opportunity	Degree of freedom to experiment and fail.
Conditions for Change	Appropriate conditions to facilitate change.
User Involvement	Support for user involvement in the development of the new technology.
Rights Ownership	Philosophy towards patent, copy right, industrial design rights ownership / coownership.
REPRESENTATIVE STAFF PROFILE	
R&D Director Influence	Willingness to back-up new technology.
User / Inventor Coop	Degree of consensus and cooperation between technology user and inventor.
Behavior Patterns	Degree to which staff behavioral patterns can be modified if necessarry.
Trust	Degree of trust between individuals involved in the transfer process.
Team Cooperation	Degree of consensus and cooperation among organizational teams or business units.
Impatience	Degree of patience for realizing results.
Complexity Aversion	Degree of aversion to complex technology.

TECHNOLOGY FACTORS INFLUENCING THE TECHNOLOGY TRANSFER PROCESS

The following technology related factors have been identified as influencial to the technology transfer process.
Review each factor and its supporting attributes and provide the most appropriate numeric rating in response to the question.

IMPORTANCE LEVEL
How important do you think this factor is in assessing the success potential for implementing new technology?

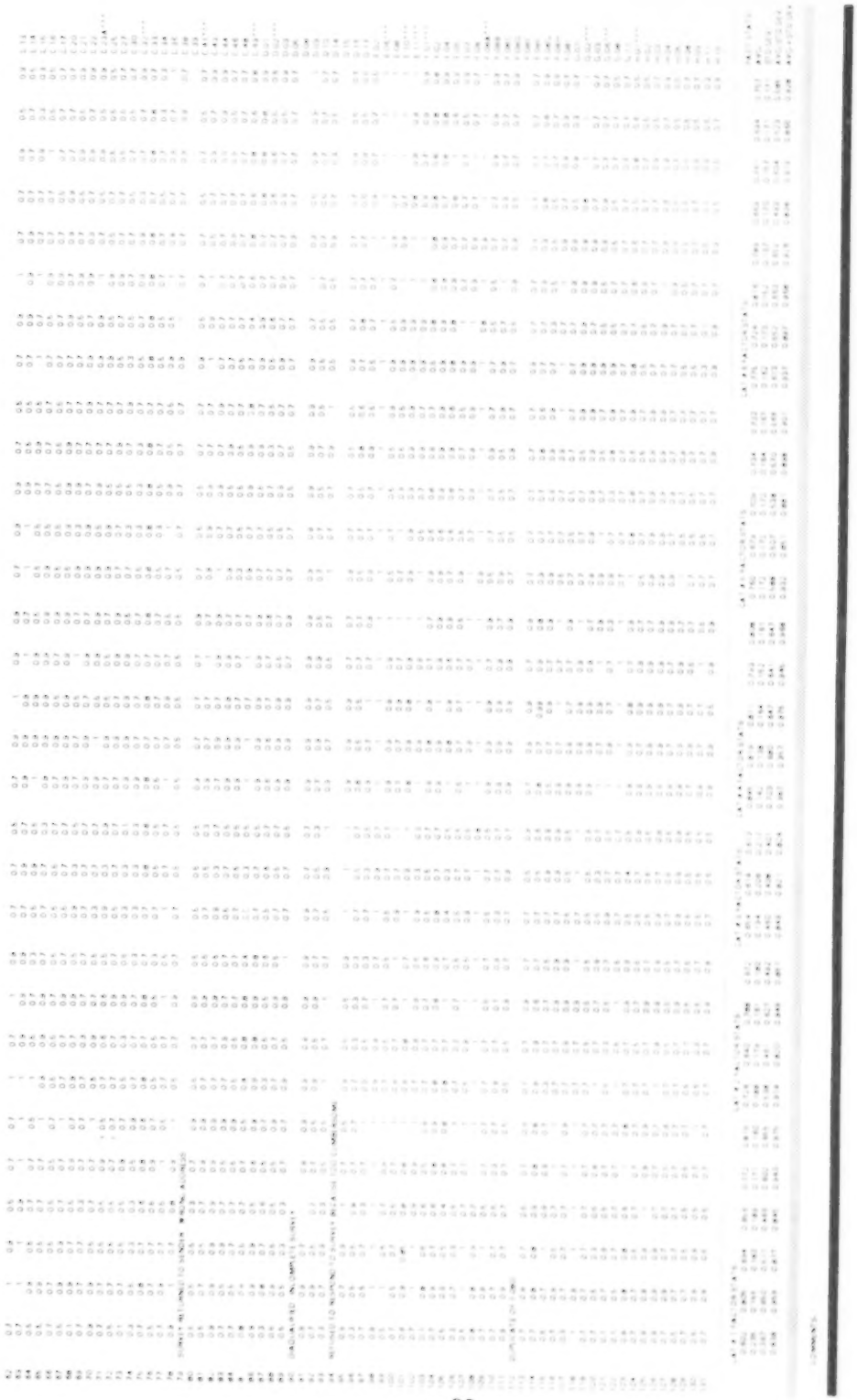
NUMERIC RATING	1	3	5	7	9	10
SUBJECTIVE RATING	NIL	LOW	MEDIUM	HIGH	V.HIGH	EXTREME

SOLUTION FEASIBILITY		
	Solution Conduciveness	How conducive the new technology is to solving current problem.
	Prototyping Time	Availability of an adequate amount of time for prototyping.
	Evaluating / Testing Time	Availability of an adequate amount of time for testing and evaluating results.
	Accelerated testing	Existence of an accelerated testing procedure.
	Production Scaling	Existence of facility for scaling product quantities (ie. supplies).
	Skill Requirement	Skill requirements for users of technology.
	Training	Availability of training for technology users when required.
	Resource Requirement	Adequate resources availble to support the implementation.
	Additional R&D	Requirement of additional R&D to properly adapt technology.
	Technology Complexity	Level of complexity appropriate for given application.
	Technology Evaluation	Existance of performance measure criteria, test & evaluation schedules & follow up procedures.
	Alternatives	Existance of better viable alternatives.
TECHNICAL RISK		
	Technology Capability	Capability of technology to solve the problem.
	Technology Drawbacks	Possible problems or side effects from using the technology.
	Understanding Problem	The technology brokers understand the problem being addressed.
	Failure Predictability	Existance of mechanism for calculating failure potential.
	Previous Performance	Existance of a previous performance history on the technology.
	Costing Information	Ability to determine costs associated with implementing the new technology.
	C/B Estimation	Existence of mechanism for estimating costs & benefits.
TECHNOLOGY ATTRIBUTES		
	Applicable	Degree to which the technology is applicable.
	Reproducable	Degree to which the technology is reproducable.
	Transferable	Degree to which the technology is transferable.
	Practical	Degree to which the technology is practical.
	Compatibility	Degree of compatibility with existing procedures.
	Addeptable	Degree to which the technology is adeptable.
	Workable	Degree to which the technology is workable.
	Documentable	Degree to which the technology is documentable.
	Implementable	Degree to which the technology is implementable.
TECHNOLOGY EFFECTIVENESS		
	Ease of Evaluation	Degree to which the technology is easy to evaluate.
	Results	Degree to which the results are tangible & quantifiable.
	Problem Addressed	Degree to which the technology directly addresses the problem.
	Adequate	Degreee to which the technology is capable to adequately solve the problem.
	Reliable	Degree to which the technology is reliable.
	Produces Improvement	Whether the technology produces improvements over the current situation.
	Spinoff Applications	Possibility of applying technology for other problems or suppport other reseach efforts.
	Benefits Exceed Costs	Degree to which the benefits exceed implementation cost.
	Benefits Immediate	How immediate the benefits are realized.
	Benefit Duration	How long the benefits last.
	Contribute to S-O-A	Degree to which the technology contributes to the state-of-the-art.
TRANSFER PROPOSAL ATTRIBUTES		
	Sustainable Profit	Technology provides a sustainable and substantial profit.
	Strategic Fit	Technology fits strategically at all the levels of the organization it affects.
	Marketing Fit	Marketing plans accommodate the technlogy being transferred.
	Financial Fit	Fiscal requirements can be accommodated in the organization's finacial planing.
	User Value	Real value to the end user established.
	Transfer Cost	Ability to determine cost of transfering the technlogy.
	Prototype Efficacy	Prototype is representative of the final solution.
TARGET ENVIRONMENT		
	End User Needs	End user needs fully addressed by the new technology.
	End User Anticipation	Anticipation for the technology as solution to prooblem.
	End User Evaluation	End user involvement in the evaluation process.
	Management Goals	Management goals achieved.
	Organization Goals	Organization goals achieved.
	Method of Operation	Operational methods in the target environment may require modification.
	Addequate Supply	Enough units availble to supply all who exhibit need.
	Acceptance Barriers	Barriers to acceptance identified and planned for.
MARKETING		
	Adequate Resources	Existance of adequate resources for proper marketing.
	Business Plan	A business plan is used as a marketing tool.
	Marketing Strategy	Existance of a marketing strategy.
	Technology Visibility	Existance of a technology awarness and promotion program.
	Target Identified	End user identified and relationship established.
	Decision Maker Identified	The highest authority required to make decision has been identified and approached.
DISTRIBUTION / DISSEMINATION		
	Training Availability	Provisions arranged for training.
	Technical Assistance	Provisions arranged for technical assistance.
	Readiness	Every aspect of the technology is "ready to go" at time of distribution.
	Implementation Support	Required resources are prepared for support during implementation.
	Introduction Rate	Best rate for technology introduction established.
	Timing	Appropriateness of timing and sufficient warning.
	Distribution System	Adequate systems in place at time of distribution.
	Documentation	Complexity of documentation explaning the technology (ie. users manuals, etc.)

COMMENTS

(If you require additonal space please use a seperate sheet and attach to survey form.)

A.2 RAW SURVEY RESULTS



ADDITIONAL COMMENTS BY SURVEY RESPONDENTS:

A17
- all factors important since failure in one could result in overall implementation failure
- survey itself could be used as a checklist to screen candidate technologies

A29
- print size too small

A32
- felt that many factor attributes started becoming repetitive

A44-
- "attitude" is the most important factor and the most difficult to establish

A52
- survey difficult to respond to, factors difficult to assess because of the numerous attributes that were used to describe each factor

B09
- print size too small

B27
- print size too small
- somewhat repetitive & hard to understand (possibly rewording would help)

B30
- **would like a copy of final report**
- responses to survey depend on which of two perspectives are used (from public sector or from private sector)

B35
- very well defined survey

B38
- person to person technology transfer is most effective
- availability of training and resources to implement for the user is most important

B40
- the technology being marketed can be controlled, but, not the target market itself
- it is important to adapt the technology to fit the market than the converse

B49
- too complicated for a 5 minute survey
- technology should be appealing and not too complicated

C23A - other factors to consider: environment, safety, government mandate and/or legislation

C32 - credibility in the eyes of the potential end user must be established first
- technologies must be practical and applicable
- end user assistance is very important
- communication networks are critical
- effective processes or mechanisms are necessary for timely delivery of technology
- political, fiscal and environmental factors are the least important

C41 - **would like a copy of final report**
- this survey is overly detailed and difficult to respond to

C49 - very thorough survey
- some supporting attributes induce varied response, hence, the importance level is sometimes inconclusive
- effort is well appreciated and the survey serves as a catalyst for ideas

D02 - took longer than 10 minutes to complete

E06 - **would like a copy of final report**
- every factor presented is important

E10 - **would like a copy of final report**

E11 - many broad concepts to be covered in quantitative form, not easy to consolidate ratings based on several short statements

F01 - effective communication is critical, surmounting barriers in this area is most important

F08 - took liberty to distribute copy of survey to 15 other individuals

F08A - **would like a copy of final results**
- technology transfer is primary duty of a technical specialist

G02 - support from senior management is necessary for implementing new technology

G06 - net present value should be used rather than payback time in economic analysis

H01 - a network of gatekeepers is necessary to support communications
- executive backing is critical

A.3 TEMPLATE USER DOCUMENTATION

REQUIRED SOFTWARE:

Load LOTUS 1.2.3 for WINDOWS (version 1 or higher). A working knowledge of this software is highly recommended.

REQUIRED FILES:

From the diskette supplied, **open** a file named MODELRAW.WK3. This is the system template in which the **TIPS** model resides.

Immediately **save as** the file to another name with a .WK3 extension.

Only work on the newly saved version of the template. The information on the original file is the data used in the case scenario in the thesis. This information will be lost once new input is keyed in.

Also, **open** a file named SURVEYRAW.WK3 and minimize it. Keep this file open in the background when working on the template. The MODELRAW.WK3 (or newly named duplicate) is dynamically linked to SURVEYRAW.WK3 file.

PROTECTED INFORMATION:

The first seven columns are protected as they are dynamically linked to the survey database file named SURVEYRAW.WK3.

- the first column, ***FACT NO***, is the factor identifier;
- the second column, ***FACTOR DESCRIPTION***, gives the factor description;
- the third column, ***BASE RATE***, is the sample mean derived from the survey (establishes the baseline for the model);
- the forth & fifth columns, ***STD-*** and ***STD+***, are the standard deviation values;
- the sixth column, ***SENS RNG***, represents the standard deviation range which also provides an indication of factor sensitivity as well as the confidence in survey values;
- the seventh column, ***FACT SENS***, is the actual factor sensitivity value.

DATA TO BE KEYED IN (INPUT):

There are 31 factors identified in the template. Review each factor within the context of the scenario (i.e., technology) being evaluated. Refer to the thesis text for detailed explanation of each factor.

Key into the appropriate cell location, under the column identified by ***FACT APPL***, a value of +1.0 if the factor applies in this case scenario and a value of 0.0 if it does not.

In the next column to the right, identified by ***SUP/HIND***, key in a value of +1.0 if the factor contributes positively (i.e., supports a successful final outcome), or key in a value of -1.0 if the contribution is negative (i.e., hinders a successful final outcome). If the factor does not apply, leave the cell entry blank.

Under the column identified by ***DEG***, key into the appropriate cell locations the degree of the contribution of each factor (whether negative or positive). Use the ***Numeric*** and respective ***Subjective Rating*** scales at the top of the template. Only input positive values. If the factor does not apply leave the cell entry blank.

In the column identified by **CONF** input a confidence rating using the same scales as identified immediately above. Again, if the factor does not apply leave the cell entry blank.

Finally, in the ***ADJUSTED (iA) SDR/MARR*** column input the current organizational social discount rate or minimum attractive rate of return value in the cell immediately below ***BASE (iB) SDR/MARR =***. This value will be used in calculating (iA) for each factor, factor category and overall.

AUTOMATICALLY CALCULATED RESULTS (OUTPUT):

As you enter the values the template automatically recalculates the actual rating for each factor for the particular case scenario and displays them in the appropriate cell locations in the column identified by ***ACT RATE***. At the same time aggregate values are calculated for each factor category and for the overall analysis. These values are displayed in the appropriate columns just below the 31 factors.

As the template recalculates the actual ratings, it also automatically compares the values against the baseline established from the survey and represents the results graphically on two graphs.

Success Potential

In the first graph, titled ***GRAPH #1***, the horizontal lines represent the standard deviation range of the survey values. These, in actuality, are the values from the cells located under ***SENS RNG*** bounded by the values from the cells under the ***STD-*** and ***STD+*** column.

The vertical line emanating perpendicularly and downwards from the horizontal lines represents the sample mean, or the values in the cell under the ***BASE RATE*** column.

The vertical line emanating perpendicularly and upwards from the horizontal lines represent the actual rating, or **ACT RATE**, for the respective factor.

Factor Sensitivity / Confidence

In the second graph, titled ***GRAPH #2***, the horizontal line represents factor sensitivity, which is inversely proportional to the sensitivity range. This line also graphically represents the level of confidence in the survey results for the respective factor. The numeric values are found under the ***FACT SENS*** column.

The vertical line emanating perpendicularly and downwards from the horizontal lines represent the level of confidence rated for the respective factor in a particular case scenario. The numeric values are found under the ***CONF*** column.

Both graphs provide a quick visual overview of the results for a particular case scenario in comparison to the baselines established through a survey of industry experts.

Recommended Actions

The cells under the column titled ***RECOMMENDED ACTIONS*** provides information on the type of action that should be considered to ensure a overall positive outcome. This information is also automatically provided once the case scenario data has been input.

Economic Evaluation

Finally, the column furthest right, entitled ***ADJUSTED (iA) SDR/MARR***, provides recommended internal rate of return values for use in an economic analysis of the technology.

OPTIONS:

Four perspectives of the same information are possible for any particular case scenario. They are:
- baseline factor importance;
- degree of baseline factor sensitivity (and confidence);
- case scenario success potential factor rating;
- case scenario confidence rating.

To accomplish all this, the data in columns 3 through 7 (from the left) must be converted from formulas (in actuality they are dynamic links to the database file) to actual values. This can be accomplished using the **RANGE-VALUE** menu features in LOTUS 1.2.3. This must be done for all "factors", the "factor categories" and the "overall". Once this is done, save the file.

To get the different perspectives use the **DATA-SORT** features in LOTUS 1.2.3. Using the mouse pointer establish a range which encompasses all the columns for all 31 factors. Once this is done, use the **DATA-SORT** command as follows for each perspective, respectively:

Baseline Factor Importance -> sort on ***BASE RATE*** column using the descending option.

Baseline Factor Sensitivity (Confidence) -> sort on ***FACT SENS*** column using the descending option.

Case Scenario Success Potential -> sort on ***ACT RATE*** column using the descending option.

Case Scenario Confidence -> sort on ***CONF*** column using the descending option.

The same procedures can be used on the category aggregates to obtain the various perspectives.

SUMMARY:

In summary, input is required for four cells for each factor. Everything else is calculated automatically. Additional pertinent information explaining the process involved (i.e., the algorithms used, etc.) are presented on the template itself.

A.4 TEMPLATE FORMULAS

	A	B	C	D	E	F
8		FACTOR DETAILS:				
9						
10		FACT	FACTOR	BASE		STD-
11		NO	DESCRIPTION	RATE		
12						
13						
14		CASE SCENARIO:		EXPERT SYSTEMS		
15						
16						
17		C1F1	Org Structure	+<<A:\RFMSC\123FILES\THESIS\SURV_RAW.WK3>>A:C149..A:C149		+<<A:\RFMSC\123FILES\THESIS\SURV_RAW.WK3>>A:C151..A:C151
18		C1F2	TT Infrastructure	+<<A:\RFMSC\123FILES\THESIS\SURV_RAW.WK3>>A:E149..A:E149		+<<A:\RFMSC\123FILES\THESIS\SURV_RAW.WK3>>A:E151..A:E151
19		C1F3	Info Flow	+<<A:\RFMSC\123FILES\THESIS\SURV_RAW.WK3>>A:G149..A:G149		+<<A:\RFMSC\123FILES\THESIS\SURV_RAW.WK3>>A:G151..A:G151
20		C1F4	Info Access	+<<A:\RFMSC\123FILES\THESIS\SURV_RAW.WK3>>A:I149..A:I149		+<<A:\RFMSC\123FILES\THESIS\SURV_RAW.WK3>>A:I151..A:I151
21		C1F5	TT Mechanisms	+<<A:\RFMSC\123FILES\THESIS\SURV_RAW.WK3>>A:K149..A:K149		+<<A:\RFMSC\123FILES\THESIS\SURV_RAW.WK3>>A:K151..A:K151
22		C1F6	TT Aproach	+<<A:\RFMSC\123FILES\THESIS\SURV_RAW.WK3>>A:M149..A:M149		+<<A:\RFMSC\123FILES\THESIS\SURV_RAW.WK3>>A:M151..A:M151
23		C2F1	Tech Lifecycle	+<<A:\RFMSC\123FILES\THESIS\SURV_RAW.WK3>>A:O149..A:O149		+<<A:\RFMSC\123FILES\THESIS\SURV_RAW.WK3>>A:O151..A:O151
24		C2F2	Research Plan	+<<A:\RFMSC\123FILES\THESIS\SURV_RAW.WK3>>A:Q149..A:Q149		+<<A:\RFMSC\123FILES\THESIS\SURV_RAW.WK3>>A:Q151..A:Q151
25		C2F3	Resources	+<<A:\RFMSC\123FILES\THESIS\SURV_RAW.WK3>>A:S149..A:S149		+<<A:\RFMSC\123FILES\THESIS\SURV_RAW.WK3>>A:S151..A:S151
26		C2F4	Costs	+<<A:\RFMSC\123FILES\THESIS\SURV_RAW.WK3>>A:U149..A:U149		+<<A:\RFMSC\123FILES\THESIS\SURV_RAW.WK3>>A:U151..A:U151
27		C3F1	Industry Trends	+<<A:\RFMSC\123FILES\THESIS\SURV_RAW.WK3>>A:W149..A:W149		+<<A:\RFMSC\123FILES\THESIS\SURV_RAW.WK3>>A:W151..A:W151
28		C3F2	Political	+<<A:\RFMSC\123FILES\THESIS\SURV_RAW.WK3>>A:Y149..A:Y149		+<<A:\RFMSC\123FILES\THESIS\SURV_RAW.WK3>>A:Y151..A:Y151
29		C3F3	Economic	+<<A:\RFMSC\123FILES\THESIS\SURV_RAW.WK3>>A:AA149..A:AA14		+<<A:\RFMSC\123FILES\THESIS\SURV_RAW.WK3>>A:AA151..A:AA15
30		C4F1	End User	+<<A:\RFMSC\123FILES\THESIS\SURV_RAW.WK3>>A:AC149..A:AC14		+<<A:\RFMSC\123FILES\THESIS\SURV_RAW.WK3>>A:AC151..A:AC15
31		C4F2	Mgr. / Supervisor	+<<A:\RFMSC\123FILES\THESIS\SURV_RAW.WK3>>A:AE149..A:AE149		+<<A:\RFMSC\123FILES\THESIS\SURV_RAW.WK3>>A:AE151..A:AE151
32		C4F3	Tech Champion	+<<A:\RFMSC\123FILES\THESIS\SURV_RAW.WK3>>A:AG149..A:AG14		+<<A:\RFMSC\123FILES\THESIS\SURV_RAW.WK3>>A:AG151..A:AG15
33		C4F4	Decision Maker	+<<A:\RFMSC\123FILES\THESIS\SURV_RAW.WK3>>A:AI149..A:AI149		+<<A:\RFMSC\123FILES\THESIS\SURV_RAW.WK3>>A:AI151..A:AI151
34		C4F5	Transfer Agent	+<<A:\RFMSC\123FILES\THESIS\SURV_RAW.WK3>>A:AK149..A:AK149		+<<A:\RFMSC\123FILES\THESIS\SURV_RAW.WK3>>A:AK151..A:AK151
35		C5F1	Corp Culture	+<<A:\RFMSC\123FILES\THESIS\SURV_RAW.WK3>>A:AM149..A:AM14		+<<A:\RFMSC\123FILES\THESIS\SURV_RAW.WK3>>A:AM151..A:AM15
36		C5F2	Current Situation	+<<A:\RFMSC\123FILES\THESIS\SURV_RAW.WK3>>A:AO149..A:AO14		+<<A:\RFMSC\123FILES\THESIS\SURV_RAW.WK3>>A:AO151..A:AO15
37		C5F3	Corp Policy	+<<A:\RFMSC\123FILES\THESIS\SURV_RAW.WK3>>A:AQ149..A:AQ14		+<<A:\RFMSC\123FILES\THESIS\SURV_RAW.WK3>>A:AQ151..A:AQ15
38		C5F4	Org Environment	+<<A:\RFMSC\123FILES\THESIS\SURV_RAW.WK3>>A:AS149..A:AS149		+<<A:\RFMSC\123FILES\THESIS\SURV_RAW.WK3>>A:AS151..A:AS151
39		C5F5	Staff Profile	+<<A:\RFMSC\123FILES\THESIS\SURV_RAW.WK3>>A:AU149..A:AU14		+<<A:\RFMSC\123FILES\THESIS\SURV_RAW.WK3>>A:AU151..A:AU15
40		C6F1	Solution Feasibility	+<<A:\RFMSC\123FILES\THESIS\SURV_RAW.WK3>>A:AW149..A:AW14		+<<A:\RFMSC\123FILES\THESIS\SURV_RAW.WK3>>A:AW151..A:AW15
41		C6F2	Technical Risk	+<<A:\RFMSC\123FILES\THESIS\SURV_RAW.WK3>>A:AY149..A:AY149		+<<A:\RFMSC\123FILES\THESIS\SURV_RAW.WK3>>A:AY151..A:AY151
42		C6F3	Tech Attributes	+<<A:\RFMSC\123FILES\THESIS\SURV_RAW.WK3>>A:BA149..A:BA149		+<<A:\RFMSC\123FILES\THESIS\SURV_RAW.WK3>>A:BA151..A:BA151
43		C6F4	Tech Effectiveness	+<<A:\RFMSC\123FILES\THESIS\SURV_RAW.WK3>>A:BC149..A:BC149		+<<A:\RFMSC\123FILES\THESIS\SURV_RAW.WK3>>A:BC151..A:BC151
44		C6F5	Transfer Proposal	+<<A:\RFMSC\123FILES\THESIS\SURV_RAW.WK3>>A:BE149..A:BE149		+<<A:\RFMSC\123FILES\THESIS\SURV_RAW.WK3>>A:BE151..A:BE151
45		C6F6	Target Environment	+<<A:\RFMSC\123FILES\THESIS\SURV_RAW.WK3>>A:BG149..A:BG149		+<<A:\RFMSC\123FILES\THESIS\SURV_RAW.WK3>>A:BG151..A:BG151
46		C6F7	Marketing	+<<A:\RFMSC\123FILES\THESIS\SURV_RAW.WK3>>A:BI149..A:BI149		+<<A:\RFMSC\123FILES\THESIS\SURV_RAW.WK3>>A:BI151..A:BI151
47		C6F8	Distrib / Dissem	+<<A:\RFMSC\123FILES\THESIS\SURV_RAW.WK3>>A:BK149..A:BK149		+<<A:\RFMSC\123FILES\THESIS\SURV_RAW.WK3>>A:BK151..A:BK151
48						
49		AVG:	CATEGORIES			
50		C1	Communications	@AVG(E17..E22)		@AVG(F17..F22)
51		C2	Financial	@AVG(E23..E26)		@AVG(F23..F26)
52		C3	External	@AVG(E27..E29)		@AVG(F27..F29)
53		C4	Human	@AVG(E30..E34)		@AVG(F30..F34)
54		C5	Corporate	@AVG(E35..E39)		@AVG(F35..F39)
55		C6	Technology	@AVG(E40..E47)		@AVG(F40..F47)
56						
57						
58						
59		TOT:	OVERALL	@AVG(E17..E47)		@AVG(F17..F47)
60						
61						
62						
63						

	A	G	H	I	J
8					
9					
10		STD→	SENS RNG	FACT SENS	
11					
12					
13					
14					
15					
16					
17		+<<A:\RFMSC\123FILES\THESIS\SURV_RAW.WK3>>A:C152..A:C152	+G17-F17	1-H17	
18		+<<A:\RFMSC\123FILES\THESIS\SURV_RAW.WK3>>A:E152..A:E152	+G18-F18	1-H18	
19		+<<A:\RFMSC\123FILES\THESIS\SURV_RAW.WK3>>A:G152..A:G152	+G19-F19	1-H19	
20		+<<A:\RFMSC\123FILES\THESIS\SURV_RAW.WK3>>A:I152..A:I152	+G20-F20	1-H20	
21		+<<A:\RFMSC\123FILES\THESIS\SURV_RAW.WK3>>A:K152..A:K152	+G21-F21	1-H21	
22		+<<A:\RFMSC\123FILES\THESIS\SURV_RAW.WK3>>A:M152..A:M152	+G22-F22	1-H22	
23		+<<A:\RFMSC\123FILES\THESIS\SURV_RAW.WK3>>A:O152..A:O152	+G23-F23	1-H23	
24		+<<A:\RFMSC\123FILES\THESIS\SURV_RAW.WK3>>A:Q152..A:Q152	+G24-F24	1-H24	
25		+<<A:\RFMSC\123FILES\THESIS\SURV_RAW.WK3>>A:S152..A:S152	+G25-F25	1-H25	
26		+<<A:\RFMSC\123FILES\THESIS\SURV_RAW.WK3>>A:U152..A:U152	+G26-F26	1-H26	
27		+<<A:\RFMSC\123FILES\THESIS\SURV_RAW.WK3>>A:W152..A:W152	+G27-F27	1-H27	
28		+<<A:\RFMSC\123FILES\THESIS\SURV_RAW.WK3>>A:Y152..A:Y152	+G28-F28	1-H28	
29		+<<A:\RFMSC\123FILES\THESIS\SURV_RAW.WK3>>A:AA152..A:AA15	+G29-F29	1-H29	
30		+<<A:\RFMSC\123FILES\THESIS\SURV_RAW.WK3>>A:AC152..A:AC15	+G30-F30	1-H30	
31		+<<A:\RFMSC\123FILES\THESIS\SURV_RAW.WK3>>A:AE152..A:AE152	+G31-F31	1-H31	
32		+<<A:\RFMSC\123FILES\THESIS\SURV_RAW.WK3>>A:AG152..A:AG15	+G32-F32	1-H32	
33		+<<A:\RFMSC\123FILES\THESIS\SURV_RAW.WK3>>A:AI152..A:AI152	+G33-F33	1-H33	
34		+<<A:\RFMSC\123FILES\THESIS\SURV_RAW.WK3>>A:AK152..A:AK152	+G34-F34	1-H34	
35		+<<A:\RFMSC\123FILES\THESIS\SURV_RAW.WK3>>A:AM152..A:AM15	+G35-F35	1-H35	
36		+<<A:\RFMSC\123FILES\THESIS\SURV_RAW.WK3>>A:AO152..A:AO15	+G36-F36	1-H36	
37		+<<A:\RFMSC\123FILES\THESIS\SURV_RAW.WK3>>A:AQ152..A:AQ15	+G37-F37	1-H37	
38		+<<A:\RFMSC\123FILES\THESIS\SURV_RAW.WK3>>A:AS152..A:AS152	+G38-F38	1-H38	
39		+<<A:\RFMSC\123FILES\THESIS\SURV_RAW.WK3>>A:AU152..A:AU15	+G39-F39	1-H39	
40		+<<A:\RFMSC\123FILES\THESIS\SURV_RAW.WK3>>A:AW152..A:AW15	+G40-F40	1-H40	
41		+<<A:\RFMSC\123FILES\THESIS\SURV_RAW.WK3>>A:AY152..A:AY152	+G41-F41	1-H41	
42		+<<A:\RFMSC\123FILES\THESIS\SURV_RAW.WK3>>A:BA152..A:BA152	+G42-F42	1-H42	
43		+<<A:\RFMSC\123FILES\THESIS\SURV_RAW.WK3>>A:BC152..A:BC152	+G43-F43	1-H43	
44		+<<A:\RFMSC\123FILES\THESIS\SURV_RAW.WK3>>A:BE152..A:BE152	+G44-F44	1-H44	
45		+<<A:\RFMSC\123FILES\THESIS\SURV_RAW.WK3>>A:BG152..A:BG152	+G45-F45	1-H45	
46		+<<A:\RFMSC\123FILES\THESIS\SURV_RAW.WK3>>A:BI152..A:BI152	+G46-F46	1-H46	
47		+<<A:\RFMSC\123FILES\THESIS\SURV_RAW.WK3>>A:BK152..A:BK152	+G47-F47	1-H47	
48					
49					
50		@AVG(G17..G22)	@AVG(H17..H22)	@AVG(I17..I22)	
51		@AVG(G23..G26)	@AVG(H23..H26)	@AVG(I23..I26)	
52		@AVG(G27..G29)	@AVG(H27..H29)	@AVG(I27..I29)	
53		@AVG(G30..G34)	@AVG(H30..H34)	@AVG(I30..I34)	
54		@AVG(G35..G39)	@AVG(H35..H39)	@AVG(I35..I39)	
55		@AVG(G40..G47)	@AVG(H40..H47)	@AVG(I40..I47)	
56					
57					
58					
59		@AVG(G17..G47)	@AVG(H17..H47)	@AVG(I17..I47)	
60					
61					
62					
63					

A	K	L	M	N	O	P
8	SCENARIO DETAILS:					
9						
10	FACT	SUP /	DEG	CONF	ACT	
11	APPL	HIND			RATE	
12						
13						
14						
15						
16						
17					+K17*((E17+((H17/2)*L17*M17))+(N17-I17)*(H17/2))	
18					+K18*((E18+((H18/2)*L18*M18))+(N18-I18)*(H18/2))	
19					+K19*((E19+((H19/2)*L19*M19))+(N19-I19)*(H19/2))	
20					+K20*((E20+((H20/2)*L20*M20))+(N20-I20)*(H20/2))	
21					+K21*((E21+((H21/2)*L21*M21))+(N21-I21)*(H21/2))	
22					+K22*((E22+((H22/2)*L22*M22))+(N22-I22)*(H22/2))	
23					+K23*((E23+((H23/2)*L23*M23))+(N23-I23)*(H23/2))	
24					+K24*((E24+((H24/2)*L24*M24))+(N24-I24)*(H24/2))	
25					+K25*((E25+((H25/2)*L25*M25))+(N25-I25)*(H25/2))	
26					+K26*((E26+((H26/2)*L26*M26))+(N26-I26)*(H26/2))	
27					+K27*((E27+((H27/2)*L27*M27))+(N27-I27)*(H27/2))	
28					+K28*((E28+((H28/2)*L28*M28))+(N28-I28)*(H28/2))	
29					+K29*((E29+((H29/2)*L29*M29))+(N29-I29)*(H29/2))	
30					+K30*((E30+((H30/2)*L30*M30))+(N30-I30)*(H30/2))	
31					+K31*((E31+((H31/2)*L31*M31))+(N31-I31)*(H31/2))	
32					+K32*((E32+((H32/2)*L32*M32))+(N32-I32)*(H32/2))	
33					+K33*((E33+((H33/2)*L33*M33))+(N33-I33)*(H33/2))	
34					+K34*((E34+((H34/2)*L34*M34))+(N34-I34)*(H34/2))	
35					+K35*((E35+((H35/2)*L35*M35))+(N35-I35)*(H35/2))	
36					+K36*((E36+((H36/2)*L36*M36))+(N36-I36)*(H36/2))	
37					+K37*((E37+((H37/2)*L37*M37))+(N37-I37)*(H37/2))	
38					+K38*((E38+((H38/2)*L38*M38))+(N38-I38)*(H38/2))	
39					+K39*((E39+((H39/2)*L39*M39))+(N39-I39)*(H39/2))	
40					+K40*((E40+((H40/2)*L40*M40))+(N40-I40)*(H40/2))	
41					+K41*((E41+((H41/2)*L41*M41))+(N41-I41)*(H41/2))	
42					+K42*((E42+((H42/2)*L42*M42))+(N42-I42)*(H42/2))	
43					+K43*((E43+((H43/2)*L43*M43))+(N43-I43)*(H43/2))	
44					+K44*((E44+((H44/2)*L44*M44))+(N44-I44)*(H44/2))	
45					+K45*((E45+((H45/2)*L45*M45))+(N45-I45)*(H45/2))	
46					+K46*((E46+((H46/2)*L46*M46))+(N46-I46)*(H46/2))	
47					+K47*((E47+((H47/2)*L47*M47))+(N47-I47)*(H47/2))	
48						
49						
50	@SUM(A17..A22)			@SUM(N17..N22)/K50	@SUM(P17..P22)/K50	
51	@SUM(A23..A26)			@SUM(N23..N26)/K51	@SUM(P23..P26)/K51	
52	@SUM(A27..A29)			@SUM(N27..N29)/K52	@SUM(P27..P29)/K52	
53	@SUM(A30..A34)			@SUM(N30..N34)/K53	@SUM(P30..P34)/K53	
54	@SUM(A35..A39)			@SUM(N35..N39)/K54	@SUM(P35..P39)/K54	
55	@SUM(A40..A47)			@SUM(N40..N47)/K55	@SUM(P40..P47)/K55	
56						
57						
58						
59	@SUM(A17..A47)			@SUM(N17..N47)/K59	@SUM(P17..P47)/K59	
60						
61						
62						
63						

A V

ACTION DETAILS

RECOMMENDED
ACTIONS

```
@IF(K17=1,@IF(P17<=F17,"ACTION LEVEL 1",@IF(P17<=E17,"ACTION LEVEL 2",@IF(P17<=G17,"ACTION LEVEL 3","ACTION LEVEL 4"))),"N/A")
@IF(K18=1,@IF(P18<=F18,"ACTION LEVEL 1",@IF(P18<=E18,"ACTION LEVEL 2",@IF(P18<=G18,"ACTION LEVEL 3","ACTION LEVEL 4"))),"N/A")
@IF(K19=1,@IF(P19<=F19,"ACTION LEVEL 1",@IF(P19<=E19,"ACTION LEVEL 2",@IF(P19<=G19,"ACTION LEVEL 3","ACTION LEVEL 4"))),"N/A")
@IF(K20=1,@IF(P20<=F20,"ACTION LEVEL 1",@IF(P20<=E20,"ACTION LEVEL 2",@IF(P20<=G20,"ACTION LEVEL 3","ACTION LEVEL 4"))),"N/A")
@IF(K21=1,@IF(P21<=F21,"ACTION LEVEL 1",@IF(P21<=E21,"ACTION LEVEL 2",@IF(P21<=G21,"ACTION LEVEL 3","ACTION LEVEL 4"))),"N/A")
@IF(K22=1,@IF(P22<=F22,"ACTION LEVEL 1",@IF(P22<=E22,"ACTION LEVEL 2",@IF(P22<=G22,"ACTION LEVEL 3","ACTION LEVEL 4"))),"N/A")
@IF(K23=1,@IF(P23<=F23,"ACTION LEVEL 1",@IF(P23<=E23,"ACTION LEVEL 2",@IF(P23<=G23,"ACTION LEVEL 3","ACTION LEVEL 4"))),"N/A")
@IF(K24=1,@IF(P24<=F24,"ACTION LEVEL 1",@IF(P24<=E24,"ACTION LEVEL 2",@IF(P24<=G24,"ACTION LEVEL 3","ACTION LEVEL 4"))),"N/A")
@IF(K25=1,@IF(P25<=F25,"ACTION LEVEL 1",@IF(P25<=E25,"ACTION LEVEL 2",@IF(P25<=G25,"ACTION LEVEL 3","ACTION LEVEL 4"))),"N/A")
@IF(K26=1,@IF(P26<=F26,"ACTION LEVEL 1",@IF(P26<=E26,"ACTION LEVEL 2",@IF(P26<=G26,"ACTION LEVEL 3","ACTION LEVEL 4"))),"N/A")
@IF(K27=1,@IF(P27<=F27,"ACTION LEVEL 1",@IF(P27<=E27,"ACTION LEVEL 2",@IF(P27<=G27,"ACTION LEVEL 3","ACTION LEVEL 4"))),"N/A")
@IF(K28=1,@IF(P28<=F28,"ACTION LEVEL 1",@IF(P28<=E28,"ACTION LEVEL 2",@IF(P28<=G28,"ACTION LEVEL 3","ACTION LEVEL 4"))),"N/A")
@IF(K29=1,@IF(P29<=F29,"ACTION LEVEL 1",@IF(P29<=E29,"ACTION LEVEL 2",@IF(P29<=G29,"ACTION LEVEL 3","ACTION LEVEL 4"))),"N/A")
@IF(K30=1,@IF(P30<=F30,"ACTION LEVEL 1",@IF(P30<=E30,"ACTION LEVEL 2",@IF(P30<=G30,"ACTION LEVEL 3","ACTION LEVEL 4"))),"N/A")
@IF(K31=1,@IF(P31<=F31,"ACTION LEVEL 1",@IF(P31<=E31,"ACTION LEVEL 2",@IF(P31<=G31,"ACTION LEVEL 3","ACTION LEVEL 4"))),"N/A")
@IF(K32=1,@IF(P32<=F32,"ACTION LEVEL 1",@IF(P32<=E32,"ACTION LEVEL 2",@IF(P32<=G32,"ACTION LEVEL 3","ACTION LEVEL 4"))),"N/A")
@IF(K33=1,@IF(P33<=F33,"ACTION LEVEL 1",@IF(P33<=E33,"ACTION LEVEL 2",@IF(P33<=G33,"ACTION LEVEL 3","ACTION LEVEL 4"))),"N/A")
@IF(K34=1,@IF(P34<=F34,"ACTION LEVEL 1",@IF(P34<=E34,"ACTION LEVEL 2",@IF(P34<=G34,"ACTION LEVEL 3","ACTION LEVEL 4"))),"N/A")
@IF(K35=1,@IF(P35<=F35,"ACTION LEVEL 1",@IF(P35<=E35,"ACTION LEVEL 2",@IF(P35<=G35,"ACTION LEVEL 3","ACTION LEVEL 4"))),"N/A")
@IF(K36=1,@IF(P36<=F36,"ACTION LEVEL 1",@IF(P36<=E36,"ACTION LEVEL 2",@IF(P36<=G36,"ACTION LEVEL 3","ACTION LEVEL 4"))),"N/A")
@IF(K37=1,@IF(P37<=F37,"ACTION LEVEL 1",@IF(P37<=E37,"ACTION LEVEL 2",@IF(P37<=G37,"ACTION LEVEL 3","ACTION LEVEL 4"))),"N/A")
@IF(K38=1,@IF(P38<=F38,"ACTION LEVEL 1",@IF(P38<=E38,"ACTION LEVEL 2",@IF(P38<=G38,"ACTION LEVEL 3","ACTION LEVEL 4"))),"N/A")
@IF(K39=1,@IF(P39<=F39,"ACTION LEVEL 1",@IF(P39<=E39,"ACTION LEVEL 2",@IF(P39<=G39,"ACTION LEVEL 3","ACTION LEVEL 4"))),"N/A")
@IF(K40=1,@IF(P40<=F40,"ACTION LEVEL 1",@IF(P40<=E40,"ACTION LEVEL 2",@IF(P40<=G40,"ACTION LEVEL 3","ACTION LEVEL 4"))),"N/A")
@IF(K41=1,@IF(P41<=F41,"ACTION LEVEL 1",@IF(P41<=E41,"ACTION LEVEL 2",@IF(P41<=G41,"ACTION LEVEL 3","ACTION LEVEL 4"))),"N/A")
@IF(K42=1,@IF(P42<=F42,"ACTION LEVEL 1",@IF(P42<=E42,"ACTION LEVEL 2",@IF(P42<=G42,"ACTION LEVEL 3","ACTION LEVEL 4"))),"N/A")
@IF(K43=1,@IF(P43<=F43,"ACTION LEVEL 1",@IF(P43<=E43,"ACTION LEVEL 2",@IF(P43<=G43,"ACTION LEVEL 3","ACTION LEVEL 4"))),"N/A")
@IF(K44=1,@IF(P44<=F44,"ACTION LEVEL 1",@IF(P44<=E44,"ACTION LEVEL 2",@IF(P44<=G44,"ACTION LEVEL 3","ACTION LEVEL 4"))),"N/A")
@IF(K45=1,@IF(P45<=F45,"ACTION LEVEL 1",@IF(P45<=E45,"ACTION LEVEL 2",@IF(P45<=G45,"ACTION LEVEL 3","ACTION LEVEL 4"))),"N/A")
@IF(K46=1,@IF(P46<=F46,"ACTION LEVEL 1",@IF(P46<=E46,"ACTION LEVEL 2",@IF(P46<=G46,"ACTION LEVEL 3","ACTION LEVEL 4"))),"N/A")
@IF(K47=1,@IF(P47<=F47,"ACTION LEVEL 1",@IF(P47<=E47,"ACTION LEVEL 2",@IF(P47<=G47,"ACTION LEVEL 3","ACTION LEVEL 4"))),"N/A")

@IF(K50>=1,@IF(P50<=F50,"ACTION LEVEL 1",@IF(P50<=E50,"ACTION LEVEL 2",@IF(P50<=G50,"ACTION LEVEL 3","ACTION LEVEL 4"))),"N/A")
@IF(K51>=1,@IF(P51<=F51,"ACTION LEVEL 1",@IF(P51<=E51,"ACTION LEVEL 2",@IF(P51<=G51,"ACTION LEVEL 3","ACTION LEVEL 4"))),"N/A")
@IF(K52>=1,@IF(P52<=F52,"ACTION LEVEL 1",@IF(P52<=E52,"ACTION LEVEL 2",@IF(P52<=G52,"ACTION LEVEL 3","ACTION LEVEL 4"))),"N/A")
@IF(K53>=1,@IF(P53<=F53,"ACTION LEVEL 1",@IF(P53<=E53,"ACTION LEVEL 2",@IF(P53<=G53,"ACTION LEVEL 3","ACTION LEVEL 4"))),"N/A")
@IF(K54>=1,@IF(P54<=F54,"ACTION LEVEL 1",@IF(P54<=E54,"ACTION LEVEL 2",@IF(P54<=G54,"ACTION LEVEL 3","ACTION LEVEL 4"))),"N/A")
@IF(K55>=1,@IF(P55<=F55,"ACTION LEVEL 1",@IF(P55<=E55,"ACTION LEVEL 2",@IF(P55<=G55,"ACTION LEVEL 3","ACTION LEVEL 4"))),"N/A")

@IF(K59>=1,@IF(P59<=F59,"ACTION LEVEL 1",@IF(P59<=E59,"ACTION LEVEL 2",@IF(P59<=G59,"ACTION LEVEL 3","ACTION LEVEL 4"))),"N/A")
```

	A	X
8	ECON DETAILS	
9		
10	ADJUSTED (sA)	
11	SDR / MARR	
12		
13	BASE (sB)	
14	SDR / MARR =	
15		10.00
16		
17	@IF(K17=1,@IF(@ABS((P17-E17)/H17/2))<=1,(-1*((P17-E17)/H17/2))*0.35+1)*X15,(-1*(((P17-E17)/H17/2))*0.125+((P17-E17)/@ABS(P17-E17))*0.35)+1)*X15),"N/A")	
18	@IF(K18=1,@IF(@ABS((P18-E18)/H18/2))<=1,(-1*((P18-E18)/H18/2))*0.35+1)*X15,(-1*(((P18-E18)/H18/2))*0.125+((P18-E18)/@ABS(P18-E18))*0.35)+1)*X15),"N/A")	
19	@IF(K19=1,@IF(@ABS((P19-E19)/H19/2))<=1,(-1*((P19-E19)/H19/2))*0.35+1)*X15,(-1*(((P19-E19)/H19/2))*0.125+((P19-E19)/@ABS(P19-E19))*0.35)+1)*X15),"N/A")	
20	@IF(K20=1,@IF(@ABS((P20-E20)/H20/2))<=1,(-1*((P20-E20)/H20/2))*0.35+1)*X15,(-1*(((P20-E20)/H20/2))*0.125+((P20-E20)/@ABS(P20-E20))*0.35)+1)*X15),"N/A")	
21	@IF(K21=1,@IF(@ABS((P21-E21)/H21/2))<=1,(-1*((P21-E21)/H21/2))*0.35+1)*X15,(-1*(((P21-E21)/H21/2))*0.125+((P21-E21)/@ABS(P21-E21))*0.35)+1)*X15),"N/A")	
22	@IF(K22=1,@IF(@ABS((P22-E22)/H22/2))<=1,(-1*((P22-E22)/H22/2))*0.35+1)*X15,(-1*(((P22-E22)/H22/2))*0.125+((P22-E22)/@ABS(P22-E22))*0.35)+1)*X15),"N/A")	
23	@IF(K23=1,@IF(@ABS((P23-E23)/H23/2))<=1,(-1*((P23-E23)/H23/2))*0.35+1)*X15,(-1*(((P23-E23)/H23/2))*0.125+((P23-E23)/@ABS(P23-E23))*0.35)+1)*X15),"N/A")	
24	@IF(K24=1,@IF(@ABS((P24-E24)/H24/2))<=1,(-1*((P24-E24)/H24/2))*0.35+1)*X15,(-1*(((P24-E24)/H24/2))*0.125+((P24-E24)/@ABS(P24-E24))*0.35)+1)*X15),"N/A")	
25	@IF(K25=1,@IF(@ABS((P25-E25)/H25/2))<=1,(-1*((P25-E25)/H25/2))*0.35+1)*X15,(-1*(((P25-E25)/H25/2))*0.125+((P25-E25)/@ABS(P25-E25))*0.35)+1)*X15),"N/A")	
26	@IF(K26=1,@IF(@ABS((P26-E26)/H26/2))<=1,(-1*((P26-E26)/H26/2))*0.35+1)*X15,(-1*(((P26-E26)/H26/2))*0.125+((P26-E26)/@ABS(P26-E26))*0.35)+1)*X15),"N/A")	
27	@IF(K27=1,@IF(@ABS((P27-E27)/H27/2))<=1,(-1*((P27-E27)/H27/2))*0.35+1)*X15,(-1*(((P27-E27)/H27/2))*0.125+((P27-E27)/@ABS(P27-E27))*0.35)+1)*X15),"N/A")	
28	@IF(K28=1,@IF(@ABS((P28-E28)/H28/2))<=1,(-1*((P28-E28)/H28/2))*0.35+1)*X15,(-1*(((P28-E28)/H28/2))*0.125+((P28-E28)/@ABS(P28-E28))*0.35)+1)*X15),"N/A")	
29	@IF(K29=1,@IF(@ABS((P29-E29)/H29/2))<=1,(-1*((P29-E29)/H29/2))*0.35+1)*X15,(-1*(((P29-E29)/H29/2))*0.125+((P29-E29)/@ABS(P29-E29))*0.35)+1)*X15),"N/A")	
30	@IF(K30=1,@IF(@ABS((P30-E30)/H30/2))<=1,(-1*((P30-E30)/H30/2))*0.35+1)*X15,(-1*(((P30-E30)/H30/2))*0.125+((P30-E30)/@ABS(P30-E30))*0.35)+1)*X15),"N/A")	
31	@IF(K31=1,@IF(@ABS((P31-E31)/H31/2))<=1,(-1*((P31-E31)/H31/2))*0.35+1)*X15,(-1*(((P31-E31)/H31/2))*0.125+((P31-E31)/@ABS(P31-E31))*0.35)+1)*X15),"N/A")	
32	@IF(K32=1,@IF(@ABS((P32-E32)/H32/2))<=1,(-1*((P32-E32)/H32/2))*0.35+1)*X15,(-1*(((P32-E32)/H32/2))*0.125+((P32-E32)/@ABS(P32-E32))*0.35)+1)*X15),"N/A")	
33	@IF(K33=1,@IF(@ABS((P33-E33)/H33/2))<=1,(-1*((P33-E33)/H33/2))*0.35+1)*X15,(-1*(((P33-E33)/H33/2))*0.125+((P33-E33)/@ABS(P33-E33))*0.35)+1)*X15),"N/A")	
34	@IF(K34=1,@IF(@ABS((P34-E34)/H34/2))<=1,(-1*((P34-E34)/H34/2))*0.35+1)*X15,(-1*(((P34-E34)/H34/2))*0.125+((P34-E34)/@ABS(P34-E34))*0.35)+1)*X15),"N/A")	
35	@IF(K35=1,@IF(@ABS((P35-E35)/H35/2))<=1,(-1*((P35-E35)/H35/2))*0.35+1)*X15,(-1*(((P35-E35)/H35/2))*0.125+((P35-E35)/@ABS(P35-E35))*0.35)+1)*X15),"N/A")	
36	@IF(K36=1,@IF(@ABS((P36-E36)/H36/2))<=1,(-1*((P36-E36)/H36/2))*0.35+1)*X15,(-1*(((P36-E36)/H36/2))*0.125+((P36-E36)/@ABS(P36-E36))*0.35)+1)*X15),"N/A")	
37	@IF(K37=1,@IF(@ABS((P37-E37)/H37/2))<=1,(-1*((P37-E37)/H37/2))*0.35+1)*X15,(-1*(((P37-E37)/H37/2))*0.125+((P37-E37)/@ABS(P37-E37))*0.35)+1)*X15),"N/A")	
38	@IF(K38=1,@IF(@ABS((P38-E38)/H38/2))<=1,(-1*((P38-E38)/H38/2))*0.35+1)*X15,(-1*(((P38-E38)/H38/2))*0.125+((P38-E38)/@ABS(P38-E38))*0.35)+1)*X15),"N/A")	
39	@IF(K39=1,@IF(@ABS((P39-E39)/H39/2))<=1,(-1*((P39-E39)/H39/2))*0.35+1)*X15,(-1*(((P39-E39)/H39/2))*0.125+((P39-E39)/@ABS(P39-E39))*0.35)+1)*X15),"N/A")	
40	@IF(K40=1,@IF(@ABS((P40-E40)/H40/2))<=1,(-1*((P40-E40)/H40/2))*0.35+1)*X15,(-1*(((P40-E40)/H40/2))*0.125+((P40-E40)/@ABS(P40-E40))*0.35)+1)*X15),"N/A")	
41	@IF(K41=1,@IF(@ABS((P41-E41)/H41/2))<=1,(-1*((P41-E41)/H41/2))*0.35+1)*X15,(-1*(((P41-E41)/H41/2))*0.125+((P41-E41)/@ABS(P41-E41))*0.35)+1)*X15),"N/A")	
42	@IF(K42=1,@IF(@ABS((P42-E42)/H42/2))<=1,(-1*((P42-E42)/H42/2))*0.35+1)*X15,(-1*(((P42-E42)/H42/2))*0.125+((P42-E42)/@ABS(P42-E42))*0.35)+1)*X15),"N/A")	
43	@IF(K43=1,@IF(@ABS((P43-E43)/H43/2))<=1,(-1*((P43-E43)/H43/2))*0.35+1)*X15,(-1*(((P43-E43)/H43/2))*0.125+((P43-E43)/@ABS(P43-E43))*0.35)+1)*X15),"N/A")	
44	@IF(K44=1,@IF(@ABS((P44-E44)/H44/2))<=1,(-1*((P44-E44)/H44/2))*0.35+1)*X15,(-1*(((P44-E44)/H44/2))*0.125+((P44-E44)/@ABS(P44-E44))*0.35)+1)*X15),"N/A")	
45	@IF(K45=1,@IF(@ABS((P45-E45)/H45/2))<=1,(-1*((P45-E45)/H45/2))*0.35+1)*X15,(-1*(((P45-E45)/H45/2))*0.125+((P45-E45)/@ABS(P45-E45))*0.35)+1)*X15),"N/A")	
46	@IF(K46=1,@IF(@ABS((P46-E46)/H46/2))<=1,(-1*((P46-E46)/H46/2))*0.35+1)*X15,(-1*(((P46-E46)/H46/2))*0.125+((P46-E46)/@ABS(P46-E46))*0.35)+1)*X15),"N/A")	
47	@IF(K47=1,@IF(@ABS((P47-E47)/H47/2))<=1,(-1*((P47-E47)/H47/2))*0.35+1)*X15,(-1*(((P47-E47)/H47/2))*0.125+((P47-E47)/@ABS(P47-E47))*0.35)+1)*X15),"N/A")	
48		
49		
50	@IF(K50>=1,@IF(@ABS((P50-E50)/H50/2))<=1,(-1*((P50-E50)/H50/2))*0.35+1)*X15,(-1*(((P50-E50)/H50/2))*0.125+((P50-E50)/@ABS(P50-E50))*0.35)+1)*X15),"N/A")	
51	@IF(K51>=1,@IF(@ABS((P51-E51)/H51/2))<=1,(-1*((P51-E51)/H51/2))*0.35+1)*X15,(-1*(((P51-E51)/H51/2))*0.125+((P51-E51)/@ABS(P51-E51))*0.35)+1)*X15),"N/A")	
52	@IF(K52>=1,@IF(@ABS((P52-E52)/H52/2))<=1,(-1*((P52-E52)/H52/2))*0.35+1)*X15,(-1*(((P52-E52)/H52/2))*0.125+((P52-E52)/@ABS(P52-E52))*0.35)+1)*X15),"N/A")	
53	@IF(K53>=1,@IF(@ABS((P53-E53)/H53/2))<=1,(-1*((P53-E53)/H53/2))*0.35+1)*X15,(-1*(((P53-E53)/H53/2))*0.125+((P53-E53)/@ABS(P53-E53))*0.35)+1)*X15),"N/A")	
54	@IF(K54>=1,@IF(@ABS((P54-E54)/H54/2))<=1,(-1*((P54-E54)/H54/2))*0.35+1)*X15,(-1*(((P54-E54)/H54/2))*0.125+((P54-E54)/@ABS(P54-E54))*0.35)+1)*X15),"N/A")	
55	@IF(K55>=1,@IF(@ABS((P55-E55)/H55/2))<=1,(-1*((P55-E55)/H55/2))*0.35+1)*X15,(-1*(((P55-E55)/H55/2))*0.125+((P55-E55)/@ABS(P55-E55))*0.35)+1)*X15),"N/A")	
56		
57		
58		
59	@IF(K59>=1,@IF(@ABS((P59-E59)/H59/2))<=1,(-1*((P59-E59)/H59/2))*0.35+1)*X15,(-1*(((P59-E59)/H59/2))*0.125+((P59-E59)/@ABS(P59-E59))*0.35)+1)*X15),"N/A")	
60		
61		
62		
63		

A.5 CASE SCENARIO RESULTS

ASSESSMENT OF EXPERT SYSTEM TECHNOLOGY IMPLEMENTATION

CATEGORY FACTOR ATTRIBUTE	APPLY? Yes = 1 No = 0	CONTRIBUTE (SCORE) Support = -1 Scale rating scale as TPS System Hinder = -1	(SCORE)	(SCORE)	(IMPEDANCE)	GOLD (SCORE/IMPEDANCE)
COMMUNICATION FACTORS						
ORGANIZATION STRUCTURE						
Decentralization	1	1	0.5	0.5	0.7	
Geographics	1	1	0.3	0.3	0.6	1 Have good potential and users located in remote field offices
Hierarchy	1	1	0.5	0.5	0.8	1 Necessary independent timely communication of important information
		FACTOR (SCORE) SUBTOTAL =		0.100		
		FACTOR (IMPEDANCE) SUBTOTAL =			0.133	
TECHNOLOGY TRANSFER INFRASTRUCTURE						
Communication Channels	1	1	1	1	1	
Transfer Team / Agent	1	1	1	1	1	
Transfer Mechanisms	1	1	1	1	1	
Process	1	1	1	1	1	
		FACTOR (SCORE) SUBTOTAL =		1.000		
		FACTOR (IMPEDANCE) SUBTOTAL =			1.000	
INFORMATION FLOW						
Communication Protocol	1	1	0.5	0.5	0.5	1 Necessary independent timely communication of important information
Industry Interface	1	1	0.5	0.5	0.5	
Internal Network	1	1	0.8	0.8	0.8	
External Network	1	1	0.3	0.3	0.8	
		FACTOR (SCORE) SUBTOTAL =		0.329		
		FACTOR (IMPEDANCE) SUBTOTAL =			0.378	
INFORMATION ACCESS						
Electronic ISDN	0			0		
Query Response	0			0		
Library Services	1	1	0.8	0.8	0.8	
		FACTOR (SCORE) SUBTOTAL =		0.400		
		FACTOR (IMPEDANCE) SUBTOTAL =			0.400	
TECHNOLOGY TRANSFER MECHANISMS						
Needs Establishment	1	1	0.8	0.8	0.8	
Current Process	1	1	0.8	0.8	0.8	
Search & Capture	1	1	0.8	0.8	0.8	
Adaptation & Translation	1	1	0.8	0.8	0.8	
Test & Evaluation	1	1	0.8	0.8	0.8	
Packaging	1	1	0.8	0.8	0.8	
Dissemination	1	1	0.8	0.8	0.8	
Media Production	1	1	0.8	0.8	0.8	
		FACTOR (SCORE) SUBTOTAL =		0.800		
		FACTOR (IMPEDANCE) SUBTOTAL =			0.800	
TECHNOLOGY TRANSFER APPROACH						
Personal Contact	1	1	0.8	0.8	0.8	
Information Packaging	1	1	0.7	0.7	0.8	
Client Involvement	1	1	0.8	0.8	0.8	
Target Identification	1	1	0.8	0.8	0.8	
Pull vs Push Approach	1	1	0.8	0.8	0.7	
		FACTOR (SCORE) SUBTOTAL =		0.780		
		FACTOR (IMPEDANCE) SUBTOTAL =			0.840	
FINANCIAL FACTORS						
PRODUCT (TECHNOLOGY) LIFECYCLE						
Payback	1	1	0.1	0.1	0.8	1 Payback values were not of any real significance
Application	1	1	0.1	0.1	0.8	
		FACTOR (SCORE) SUBTOTAL =		0.020		
		FACTOR (IMPEDANCE) SUBTOTAL =			0.640	
RESEARCH PLAN						
Organization Strategy	1	1	0.1	0.1	0.8	
Research Strategy	1	1	0.8	0.8	0.8	
Resource Commitment	1	1	0.8	0.8	0.8	
		FACTOR (SCORE) SUBTOTAL =		0.665		
		FACTOR (IMPEDANCE) SUBTOTAL =			0.800	
RESOURCES						
Human Resources	1	1	0.8	0.8	0.8	
Financial Resources	1	1	0.8	0.8	0.8	
Capital Funding	1	1	0.8	0.8	0.8	1 Hardware / software COP resources acquisition is very difficult
User Assistance	1	1	0.8	0.8	0.8	
External Resources	1	1	0.3	0.3	0.3	
		FACTOR (SCORE) SUBTOTAL =		0.380		
		FACTOR (IMPEDANCE) SUBTOTAL =			0.133	
COSTS						
Proof of Concept	1	1	0.8	0.8	0.7	
Cost to Prototype	1	1	0.8	0.8	0.7	
Cost Assertion	1	1	0.8	0.8	0.7	
		FACTOR (SCORE) SUBTOTAL =		0.665		
		FACTOR (IMPEDANCE) SUBTOTAL =			0.100	

EXTERNAL FACTORS

INDUSTRY TRENDS & DEVELOPMENTS						
Effort Duplication	1	1	0.8	0.8	0.9	
Cooperative Alliances	0			0		
Competition	0			0		
Technology Development	1	1	0.9	0.9	0.9	
	FACTOR DEGREE RATING =			0.850		
	FACTOR CONFIDENCE RATING =				0.900	
POLITICAL						
Government Regulation	0			0		
Government Stability	1	1	0.9	0.9	0.2	↓ Reluctance to embark on risky ventures
Gov't vs Private	1	1	0.9	0.9	0.4	↓ Lack of real incentive (ie. bottom line profit)
Gov't Fiscal Situation	1	1	0.9	0.9	0.3	↓ Exasperates acquisition of required resources to do the job right
Taxes and Legislation	0			0		
	FACTOR DEGREE RATING =			-0.900		
	FACTOR CONFIDENCE RATING =				0.300	
ECONOMIC						
Shrinking Economy	1	1	0.8	0.8	0.8	↓ Contributes to current government fiscal situation
Growing Economy	0			0		
Cost of Money	0			0		
	FACTOR DEGREE RATING =			-0.800		
	FACTOR CONFIDENCE RATING =				0.800	

HUMAN FACTORS

END USER						
Attitude	1	1	0.7	0.7	0.9	
Change	1	1	0.8	0.8	0.9	
Understanding	1	1	0.3	0.3	0.7	↓ No real understanding of the technology
Skill Sets	1	1	0.3	0.3	0.6	
Perception of Threat	1	1	0.3	0.3	0.7	↓ Lack of understanding fosters some concern re: job threat
Perception of Benefit	1	1	0.5	0.5	0.5	
	FACTOR DEGREE RATING =			0.250		
	FACTOR CONFIDENCE RATING =				0.717	
MANAGER / SUPERVISOR (OF THE END USER)						
Attitude	1	1	0.5	0.5	0.7	
Understanding	1	1	0.7	0.7	0.7	↓ Resistance to understand because may frustrate current eggendas
Support	1	1	0.3	0.3	0.9	
	FACTOR DEGREE RATING =			0.033		
	FACTOR CONFIDENCE RATING =				0.787	
TECHNOLOGY CHAMPION						
Attitude	1	1	1	1	0.9	
Influence	1	1	0.7	0.7	0.8	
	FACTOR DEGREE RATING =			0.860		
	FACTOR CONFIDENCE RATING =				0.850	
DECISION MAKER						
Understanding	1	1	0.7	0.7	0.7	
Support	1	1	0.9	0.9	0.9	
Benefits	1	1	0.8	0.8	0.8	
Influence	1	1	0.8	0.8	0.6	
	FACTOR DEGREE RATING =			0.800		
	FACTOR CONFIDENCE RATING =				0.750	
TRANSFER TEAM / AGENT ATTRIBUTES						
Intelligents	1	1	0.9	0.9	0.9	
General Competence	1	1	0.9	0.9	0.9	
Technical Competence	1	1	0.9	0.9	0.9	
Independence	1	1	0.8	0.8	0.9	
Team Play	1	1	0.9	0.9	0.9	
Leadership	1	1	0.9	0.9	0.9	
Persistence	1	1	0.9	0.9	0.9	
Creativity	1	1	0.8	0.8	0.9	
Credibility	1	1	0.8	0.8	0.9	
Commitment	1	1	0.9	0.9	0.9	
Articulate	1	1	1	1	0.9	
Business Sense	1	1	0.9	0.9	0.9	
People Skills	1	1	1	1	0.9	
	FACTOR DEGREE RATING =			0.892		
	FACTOR CONFIDENCE RATING =				0.900	

CORPORATE FACTORS

CORPORATE CULTURE

Reward Systems	0			0		
Corporate Philosophy	1	1	0.2	0.2	0.5	
Executive Support	1	1	0.4	0.4	0.6	
Challenge Old Paradigms	1	1	0.5	0.5	0.7	! High inertia makes abandoning existing paradigms nearly impossible.
Challenge Problems	1	1	0.5	0.5	0.7	! Risk aversion results in problems usually being solved using conservative mean
Management Philosophy	1	1	0.5	0.5	0.7	
Corporate Image	1	1	0.2	0.2	0.4	
Barriers	1	1	0.7	0.7	0.9	! Little credence is by supervisors for staff to experiment
Allowed Dreaming	1	1	0.2	0.2	0.5	
	FACTOR DEGREE RATING =			0.026		
	FACTOR CONFIDENCE RATING =				0.625	

CURRENT CORPORATE SITUATION

Priorities & Urgency	1	1	0.7	0.7	0.8	! R&D and technological innovation given little attention by senior management
Fiscal Situation	1	1	0.7	0.7	0.8	! Current fiscal situation fosters survival mentality
Do Nothing Impact	1	1	0.3	0.3	0.2	! Only tried and true methods being considered. Experimentation not common
External Solutions	1	1	0.1	0.1	0.3	
Organizational Expertise	1	1	0.5	0.5	0.3	
	FACTOR DEGREE RATING =			0.220		
	FACTOR CONFIDENCE RATING =				0.490	

CORPORATE POLICY

Tech Transfer Mandate	1	1	0.9	0.9	0.9	
Organization Mandate	1	1	0.7	0.7	0.9	
Technology Policy	1	1	0.5	0.5	0.7	
Support Mechanisms	1	1	0.5	0.5	0.9	
	FACTOR DEGREE RATING =			0.060		
	FACTOR CONFIDENCE RATING =				0.860	

ORGANIZATIONAL ENVIRONMENT

Idea Receptiveness	1	1	0.3	0.3	0.7	! In general the overall environment is not conducive to new technology implems
Crowded R&D Agenda	1	1	0.3	0.3	0.7	
Excitement Generation	1	1	0.3	0.3	0.7	! Ditto
Experiment Opportunity	1	1	0.3	0.3	0.7	! Ditto
Conditions for Change	1	1	0.5	0.5	0.7	! Ditto
User Involvement	1	1	0.4	0.4	0.7	! Ditto
Rights Ownership	0			0		
	FACTOR DEGREE RATING =			0.260		
	FACTOR CONFIDENCE RATING =				0.700	

REPRESENTATIVE STAFF PROFILE

R&D Director Influence	1	1	0.8	0.8	0.8	
User / Inventor Coop	0			0		
Behavior Patterns	1	1	0.6	0.6	0.5	
Trust	1	1	0.6	0.6	0.3	
Team Cooperation	1	1	0.6	0.6	0.5	
Impatience	0			0		
Complexity Aversion	1	1	0.7	0.7	0.9	! Common perception that change will make task more complicated or difficult
	FACTOR DEGREE RATING =			0.380		
	FACTOR CONFIDENCE RATING =				0.800	

TECHNOLOGY FACTORS

SOLUTION FEASIBILITY

Solution Conducivenese	1	1	0.8	0.8	0.9	
Prototyping Time	1	1	0.7	0.7	0.8	
Evaluating / Testing Time	1	1	0.7	0.6	0.7	
Accellerated testing	0			0		
Production Scaling	0			0		
Skill Requirement	1	1	0.7	0.7	0.7	
Training	1	1	0.7	0.7	0.9	
Resource Requirement	1	1	0.5	0.5	0.9	
Additional R&D	0			0		
Technology Complexity	1	1	0.5	0.5	0.5	
Technology Evaluation	1	1	0.5	0.5	0.5	
Alternatives	1	1	0.5	0.5	0.7	
	FACTOR DEGREE RATING =			0.611		
	FACTOR CONFIDENCE RATING =				0.733	

TECHNICAL RISK

Technology Capability	1	1	0.8	0.8	0.9	
Technology Drawbacks	1	1	0.7	0.7	0.8	
Understanding Problem	1	1	0.9	0.9	0.9	
Failure Predictability	1	1	0.4	0.4	0.7	! No real model available for predicting failure
Previous Performance	1	1	0.5	0.5	0.7	! Little if no history in industry of technology application
Costing Information	1	1	0.3	0.3	0.5	
C/B Estimation	1	1	0.5	0.5	0.5	
	FACTOR DEGREE RATING =			0.329		
	FACTOR CONFIDENCE RATING =				0.714	

TECHNOLOGY ATTRIBUTES					
Applicable	1	1	0.8	0.8	0.7
Reproducable	1	1	0.8	0.8	0.7
Transferable	1	1	0.8	0.8	0.7
Practical	1	1	0.8	0.8	0.7
Compatibility	1	1	0.8	0.8	0.7
Addaptable	1	1	0.8	0.8	0.7
Workable	1	1	0.8	0.8	0.7
Documentable	1	1	0.8	0.8	0.7
Implementable	1	1	0.8	0.8	0.7
		FACTOR DEGREE RATING =		0.800	
		FACTOR CONFIDENCE RATING =			0.700
TECHNOLOGY EFFECTIVENESS					
Ease of Evaluation	1	1	0.5	0.5	0.7
Results	1	1	0.5	0.5	0.7
Problem Addressed	1	1	0.5	0.5	0.7
Adequate	1	1	0.7	0.7	0.7
Reliable	1	1	0.7	0.7	0.6
Produces Improvement	1	1	0.7	0.7	0.6
Spinoff Applications	1	1	0.4	0.4	0.5
Benefits Exceed Costs	1	1	0.7	0.7	0.6
Benefits Immediate	1	1	0.4	0.4	0.5
Benefit Duration	1	1	0.6	0.6	0.5
Contribute to S.O.A.	1	1	0.7	0.7	0.5
		FACTOR DEGREE RATING =		0.682	
		FACTOR CONFIDENCE RATING =			0.600
TRANSFER PROPOSAL ATTRIBUTES					
Sustainable Profit	0			0	
Strategic Fit	1	1	0.8	0.8	0.7
Marketing Fit	0			0	
Financial Fit	1	1	0.7	0.7	0.6
User Value	1	1	0.8	0.8	0.7
Transfer Cost	1	1	0.7	0.7	0.7
Prototype Efficacy	0			0	
		FACTOR DEGREE RATING =		0.700	
		FACTOR CONFIDENCE RATING =			0.675
TARGET ENVIRONMENT					
End User Needs	1	1	0.8	0.8	0.7
End User Anticipation	1	1	0.6	0.6	0.7
End User Evaluation	1	1	0.7	0.7	0.7
Management Goals	1	1	0.6	0.6	0.7
Organization Goals	1	1	0.8	0.8	0.7
Method of Operation	1	1	0.8	0.8	0.7
Adequate Supply	1	1	0.8	0.8	0.7
Acceptance Barriers	1	1	0.8	0.8	0.7
		FACTOR DEGREE RATING =		0.713	
		FACTOR CONFIDENCE RATING =			0.700
MARKETING					
Adequate Resources	1	1	0.6	0.6	0.7
Business Plan	0			0	
Marketing Strategy	1	1	0.7	0.7	0.8
Technology Viability	1	1	0.9	0.9	0.9
Target Identified	1	1	0.9	0.9	0.9
Decision Maker Identified	1	1	0.9	0.9	0.9
		FACTOR DEGREE RATING =		0.800	
		FACTOR CONFIDENCE RATING =			0.840
DISTRIBUTION / DISSEMINATION					
Training Availability	1	1	0.9	0.9	0.9
Technical Assistance	1	1	0.9	0.9	0.9
Readiness	1	1	0.8	0.8	0.7
Implementation Support	1	1	0.9	0.9	0.9
Introduction Rate	1	1	0.7	0.7	0.9
Timing	1	1	0.6	0.6	0.7
Distribution System	1	1	0.7	0.7	0.7
Documentation	1	1	0.8	0.8	0.8
		FACTOR DEGREE RATING =		0.775	
		FACTOR CONFIDENCE RATING =			0.813

COMMENTS:
This is a general assessment for implementation of EXPERT SYSTEM technology within a department of transportation.
Specific prototype (ie. low, medium and high implementation success) assessment based on deviations from this general assessment.

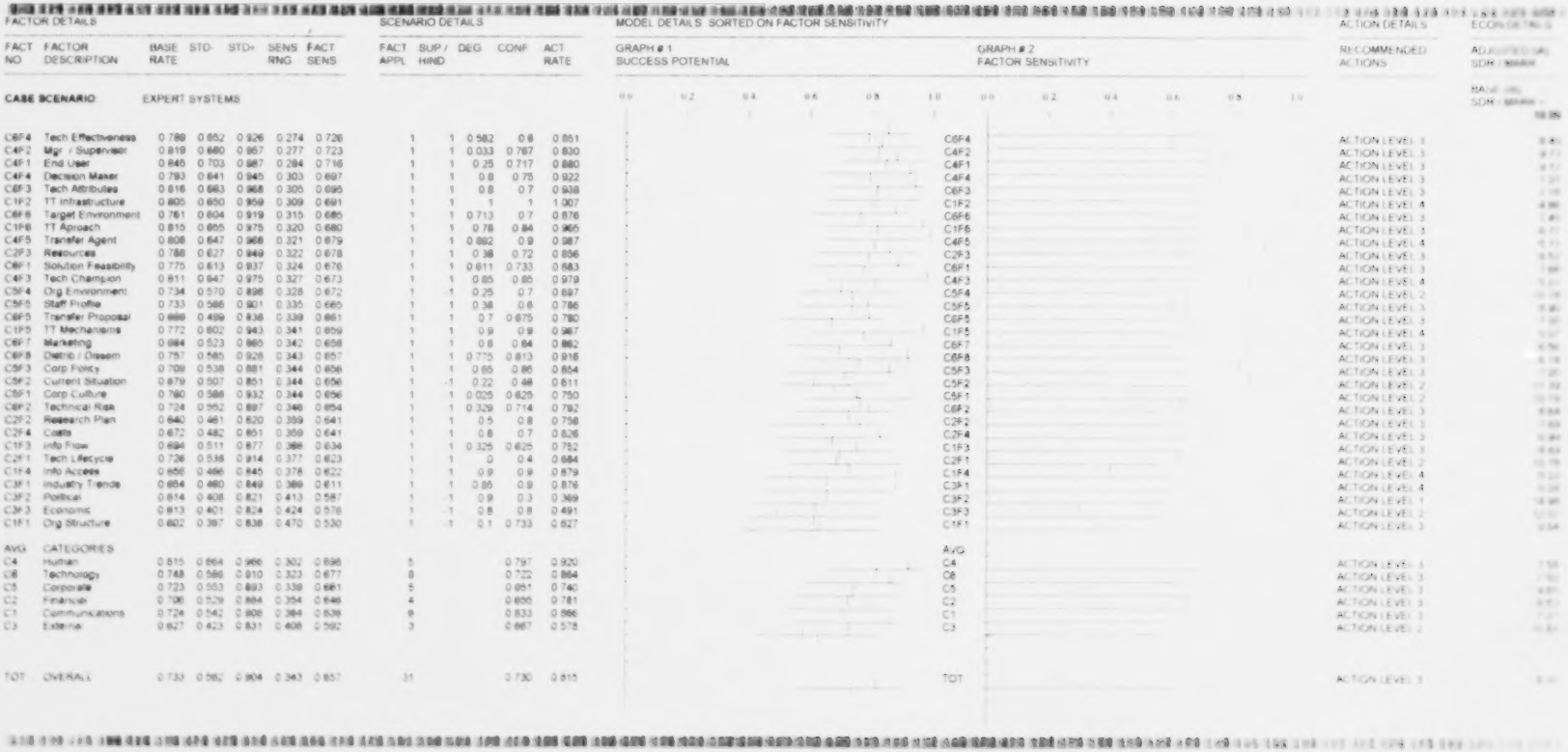
A.6 TEMPLATE PERSPECTIVES

FIGURE 8 BASE RATE PERSPECTIVE

FACTOR DETAILS | SCENARIO DETAILS | MODEL DETAILS SORTED ON BASELINE | ACTION DETAILS | ECON DETAILS

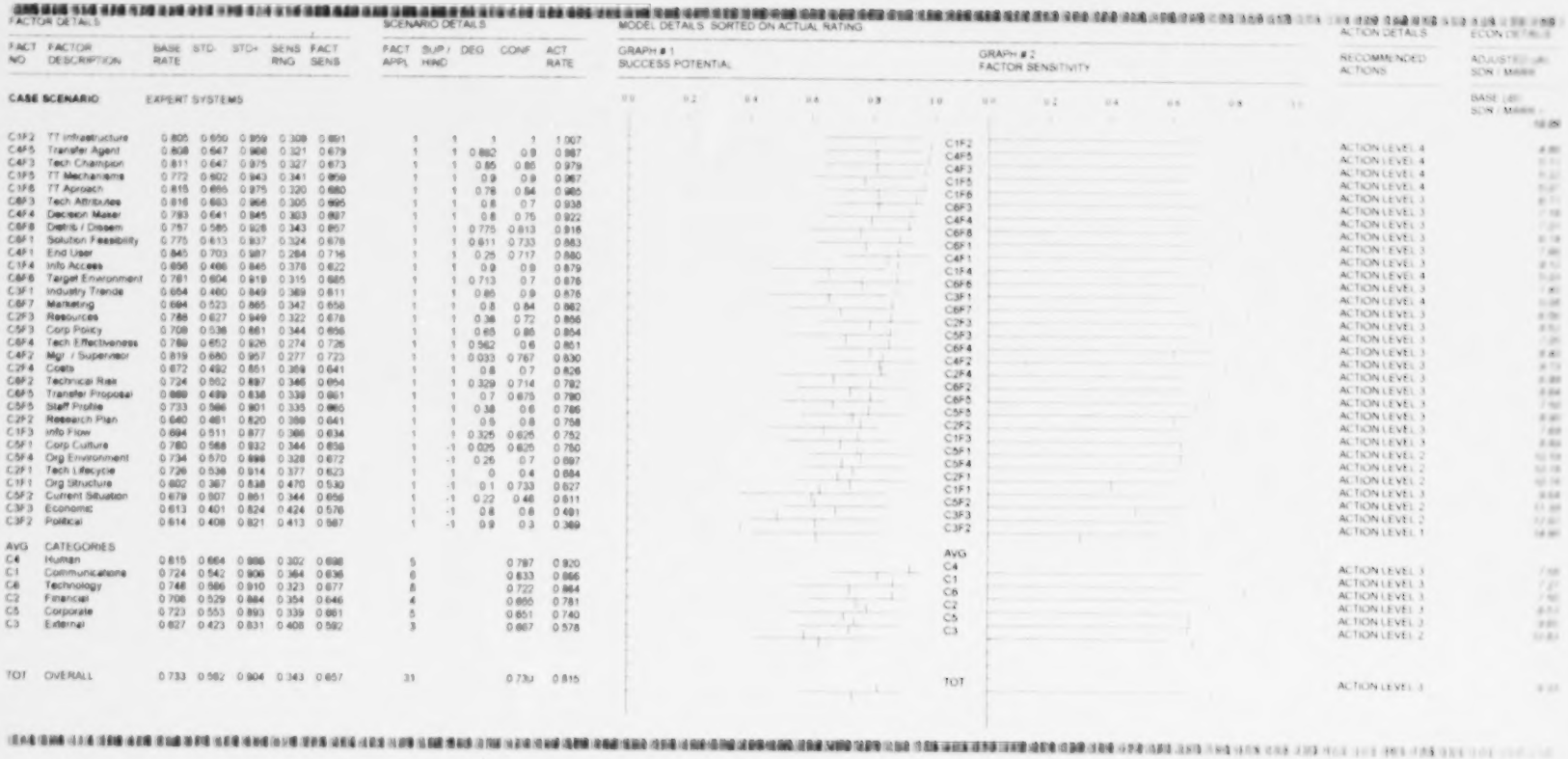
FACT NO	FACTOR DESCRIPTION	BASE RATE	STD-	STD+	SENS RNG	FACT SENS	FACT APPL	SUP / HIND	DEG	CONF	ACT RATE	GRAPH # 1 SUCCESS POTENTIAL	GRAPH # 2 FACTOR SENSITIVITY	RECOMMENDED ACTIONS	ADJUSTED (A) SUR MARK	BASE (B) SUR MARK
CASE SCENARIO	EXPERT SYSTEMS											0.0 0.2 0.4 0.6 0.8 1.0	0.0 0.2 0.4 0.6 0.8 1.0			
C4F1	End User	0.845	0.703	0.887	0.284	0.716	1	1	0.25	0.717	0.880	C4F1		ACTION LEVEL 3		
C4F2	Mgr. / Supervisor	0.819	0.680	0.957	0.277	0.723	1	1	0.033	0.767	0.830	C4F2		ACTION LEVEL 3		
C6F3	Tech Attributes	0.816	0.663	0.968	0.305	0.695	1	1	0.8	0.7	0.938	C6F3		ACTION LEVEL 3		
C1F6	TT Aproach	0.815	0.655	0.975	0.320	0.680	1	1	0.78	0.84	0.966	C1F6		ACTION LEVEL 3		
C4F3	Tech Champion	0.811	0.647	0.975	0.327	0.673	1	1	0.85	0.85	0.979	C4F3		ACTION LEVEL 4		
C4F5	Transfer Agent	0.808	0.647	0.968	0.321	0.679	1	1	0.892	0.9	0.987	C4F5		ACTION LEVEL 4		
C1F2	TT Infrastructure	0.805	0.650	0.959	0.309	0.691	1	1	1	1	1.007	C1F2		ACTION LEVEL 4		
C4F4	Decision Maker	0.793	0.641	0.965	0.303	0.697	1	1	0.8	0.75	0.922	C4F4		ACTION LEVEL 3		
C6F4	Tech Effectiveness	0.789	0.652	0.926	0.274	0.726	1	1	0.582	0.6	0.851	C6F4		ACTION LEVEL 3		
C2F3	Resources	0.788	0.627	0.949	0.322	0.678	1	1	0.38	0.72	0.856	C2F3		ACTION LEVEL 3		
C6F1	Solution Feasibility	0.775	0.613	0.937	0.324	0.676	1	1	0.611	0.733	0.883	C6F1		ACTION LEVEL 3		
C1F5	TT Mechanisms	0.772	0.602	0.943	0.341	0.659	1	1	0.9	0.9	0.967	C1F5		ACTION LEVEL 4		
C6F6	Target Environment	0.761	0.604	0.919	0.315	0.685	1	1	0.713	0.7	0.876	C6F6		ACTION LEVEL 3		
C5F1	Corp Culture	0.760	0.568	0.932	0.344	0.656	1	-1	0.025	0.625	0.750	C5F1		ACTION LEVEL 2		
C6F8	Detrib / Dissem	0.757	0.565	0.928	0.343	0.657	1	1	0.775	0.813	0.916	C6F8		ACTION LEVEL 3		
C5F4	Org Environment	0.734	0.570	0.898	0.328	0.672	1	-	0.25	0.7	0.897	C5F4		ACTION LEVEL 2		
C5F5	Staff Profile	0.733	0.566	0.901	0.335	0.665	1	1	0.38	0.6	0.786	C5F5		ACTION LEVEL 3		
C2F1	Tech Lifecycle	0.726	0.538	0.914	0.377	0.623	1	1	0	0.4	0.684	C2F1		ACTION LEVEL 2		
C6F2	Technical Risk	0.724	0.552	0.897	0.345	0.654	1	1	0.329	0.714	0.792	C6F2		ACTION LEVEL 3		
C5F3	Corp Policy	0.709	0.538	0.881	0.344	0.656	1	1	0.85	0.85	0.954	C5F3		ACTION LEVEL 3		
C1F3	Info Flow	0.694	0.511	0.877	0.366	0.634	1	1	0.325	0.825	0.752	C1F3		ACTION LEVEL 3		
C6F7	Marketing	0.694	0.523	0.865	0.342	0.658	1	1	0.8	0.84	0.862	C6F7		ACTION LEVEL 3		
C5F2	Current Situation	0.679	0.507	0.851	0.344	0.656	1	-1	0.22	0.48	0.611	C5F2		ACTION LEVEL 2		
C2F4	Costs	0.672	0.492	0.851	0.359	0.641	1	1	0.8	0.7	0.826	C2F4		ACTION LEVEL 3		
C6F5	Transfer Proposal	0.669	0.499	0.838	0.339	0.661	1	1	0.7	0.675	0.790	C6F5		ACTION LEVEL 3		
C1F4	Info Access	0.656	0.496	0.845	0.378	0.622	1	1	0.9	0.9	0.879	C1F4		ACTION LEVEL 4		
C3F1	Industry Trends	0.654	0.480	0.849	0.369	0.631	1	1	0.85	0.9	0.876	C3F1		ACTION LEVEL 4		
C2F2	Research Plan	0.640	0.461	0.820	0.359	0.641	1	1	0.5	0.8	0.758	C2F2		ACTION LEVEL 3		
C3F2	Political	0.614	0.408	0.821	0.413	0.587	1	-1	0.9	0.3	0.389	C3F2		ACTION LEVEL 1		
C3F3	Economic	0.613	0.401	0.824	0.424	0.576	1	-1	0.8	0.8	0.491	C3F3		ACTION LEVEL 2		
C1F1	Org Structure	0.602	0.387	0.838	0.470	0.530	1	-1	0.1	0.733	0.627	C1F1		ACTION LEVEL 3		
AVG	CATEGORIES											AVG				
C4	Human	0.815	0.664	0.906	0.302	0.698	5			0.797	0.920	C4		ACTION LEVEL 3		
C6	Technology	0.748	0.588	0.910	0.323	0.677	8			0.722	0.864	C6		ACTION LEVEL 3		
C1	Communications	0.724	0.542	0.908	0.364	0.636	6			0.833	0.866	C1		ACTION LEVEL 3		
C5	Corporate	0.723	0.553	0.893	0.339	0.661	5			0.651	0.740	C5		ACTION LEVEL 3		
C2	Financial	0.706	0.529	0.884	0.354	0.646	4			0.656	0.781	C2		ACTION LEVEL 3		
C3	External	0.627	0.423	0.831	0.408	0.592	3			0.667	0.578	C3		ACTION LEVEL 2		
TOT	OVERALL	0.733	0.562	0.904	0.343	0.657	31			0.730	0.815	TOT		ACTION LEVEL 3		

FIGURE 9 FACTOR SENSITIVITY RATE PERSPECTIVE



FACTOR DETAILS							SCENARIO DETAILS					MODEL DETAILS SORTED ON FACTOR SENSITIVITY		ACTION DETAILS	ECON DETAILS
FACT NO	FACTOR DESCRIPTION	BASE RATE	STD-	STD+	SENS RNG	FACT SENS	FACT APPL	SUP / HIND	DEG	CONF	ACT RATE	GRAPH # 1 SUCCESS POTENTIAL	GRAPH # 2 FACTOR SENSITIVITY	RECOMMENDED ACTIONS	ADJUSTED (AV) SDM - BASE
CASE SCENARIO:		EXPERT SYSTEMS										0.0 0.2 0.4 0.6 0.8 1.0	0.0 0.2 0.4 0.6 0.8 1.0		BASE (AV) SDM - ADJUSTED
C6F4	Tech Effectiveness	0.789	0.652	0.926	0.274	0.726	1	1	0.582	0.6	0.861		C6F4	ACTION LEVEL 3	0.8
C4F2	Mgr / Supervisor	0.819	0.680	0.957	0.277	0.723	1	1	0.033	0.787	0.830		C4F2	ACTION LEVEL 3	0.71
C4F1	End User	0.846	0.703	0.987	0.284	0.716	1	1	0.25	0.717	0.880		C4F1	ACTION LEVEL 3	0.77
C4F4	Decision Maker	0.793	0.641	0.945	0.303	0.697	1	1	0.8	0.75	0.922		C4F4	ACTION LEVEL 3	1.07
C6F3	Tech Attributes	0.816	0.683	0.968	0.305	0.695	1	1	0.8	0.7	0.938		C6F3	ACTION LEVEL 3	1.19
C1F2	TT Infrastructure	0.805	0.650	0.959	0.309	0.691	1	1	1	1	1.007		C1F2	ACTION LEVEL 4	0.99
C6F6	Target Environment	0.761	0.604	0.919	0.315	0.685	1	1	0.713	0.7	0.876		C6F6	ACTION LEVEL 3	1.41
C1F6	TT Aproach	0.815	0.655	0.975	0.320	0.680	1	1	0.78	0.84	0.965		C1F6	ACTION LEVEL 3	0.77
C4F5	Transfer Agent	0.808	0.647	0.968	0.321	0.679	1	1	0.882	0.9	0.987		C4F5	ACTION LEVEL 4	0.71
C2F3	Resources	0.788	0.627	0.949	0.322	0.678	1	1	0.38	0.72	0.896		C2F3	ACTION LEVEL 3	0.92
C6F1	Solution Feasibility	0.775	0.613	0.937	0.324	0.676	1	1	0.611	0.733	0.883		C6F1	ACTION LEVEL 3	1.08
C4F3	Tech Champion	0.811	0.647	0.975	0.327	0.673	1	1	0.85	0.85	0.979		C4F3	ACTION LEVEL 4	0.71
C5F4	Org Environment	0.734	0.570	0.898	0.328	0.672	1	-1	0.25	0.7	0.697		C5F4	ACTION LEVEL 2	0.19
C5F5	Staff Profile	0.733	0.566	0.901	0.335	0.665	1	1	0.38	0.6	0.786		C5F5	ACTION LEVEL 3	0.81
C6F5	Transfer Proposal	0.666	0.499	0.838	0.339	0.661	1	1	0.7	0.675	0.780		C6F5	ACTION LEVEL 3	0.90
C1F5	TT Mechanisms	0.772	0.602	0.943	0.341	0.659	1	1	0.9	0.9	0.967		C1F5	ACTION LEVEL 4	0.97
C6F7	Marketing	0.684	0.523	0.865	0.342	0.658	1	1	0.8	0.64	0.862		C6F7	ACTION LEVEL 3	0.76
C6F8	Detrib / Dissem	0.757	0.585	0.928	0.343	0.657	1	1	0.775	0.813	0.916		C6F8	ACTION LEVEL 3	0.78
C5F3	Corp Policy	0.709	0.538	0.881	0.344	0.656	1	1	0.65	0.85	0.854		C5F3	ACTION LEVEL 3	1.07
C5F2	Current Situation	0.679	0.507	0.851	0.344	0.656	1	-1	0.22	0.48	0.611		C5F2	ACTION LEVEL 2	0.19
C5F1	Corp Culture	0.760	0.588	0.932	0.344	0.656	1	1	0.025	0.625	0.750		C5F1	ACTION LEVEL 2	0.19
C6F2	Technical Risk	0.724	0.552	0.897	0.346	0.654	1	1	0.329	0.714	0.792		C6F2	ACTION LEVEL 3	0.84
C2F2	Research Plan	0.640	0.461	0.820	0.359	0.641	1	1	0.5	0.8	0.758		C2F2	ACTION LEVEL 3	0.83
C2F4	Costs	0.672	0.482	0.851	0.369	0.641	1	1	0.8	0.7	0.826		C2F4	ACTION LEVEL 3	0.89
C1F3	Info Flow	0.694	0.511	0.877	0.366	0.634	1	1	0.325	0.625	0.752		C1F3	ACTION LEVEL 3	0.83
C2F1	Tech Lifecycle	0.726	0.538	0.914	0.377	0.623	1	1	0	0.4	0.684		C2F1	ACTION LEVEL 2	0.19
C1F4	Info Access	0.656	0.466	0.845	0.378	0.622	1	1	0.9	0.9	0.879		C1F4	ACTION LEVEL 4	0.84
C3F1	Industry Trends	0.654	0.480	0.849	0.369	0.611	1	1	0.85	0.9	0.876		C3F1	ACTION LEVEL 4	0.84
C3F2	Political	0.614	0.408	0.821	0.413	0.587	1	-1	0.9	0.3	0.369		C3F2	ACTION LEVEL 1	0.49
C3F3	Economic	0.613	0.401	0.824	0.424	0.576	1	-1	0.8	0.8	0.491		C3F3	ACTION LEVEL 2	0.51
C1F1	Org Structure	0.602	0.387	0.838	0.470	0.530	1	-1	0.1	0.733	0.627		C1F1	ACTION LEVEL 3	0.64
AVG	CATEGORIES												AVG		
C4	Human	0.815	0.664	0.966	0.302	0.698	5			0.797	0.920		C4	ACTION LEVEL 3	0.78
C6	Technology	0.748	0.586	0.910	0.323	0.677	8			0.722	0.864		C6	ACTION LEVEL 3	0.82
C5	Corporate	0.723	0.553	0.893	0.339	0.661	5			0.651	0.740		C5	ACTION LEVEL 3	0.85
C2	Financial	0.706	0.529	0.884	0.354	0.646	4			0.656	0.781		C2	ACTION LEVEL 3	0.83
C1	Communications	0.724	0.542	0.908	0.364	0.636	6			0.833	0.866		C1	ACTION LEVEL 3	0.87
C3	External	0.627	0.423	0.831	0.408	0.592	3			0.667	0.578		C3	ACTION LEVEL 2	0.51
TOT	OVERALL	0.733	0.582	0.904	0.343	0.657	31			0.730	0.815		TOT	ACTION LEVEL 3	0.81

FIGURE 10 ACTUAL RATE PERSPECTIVE



FACTOR DETAILS

FACT NO	FACTOR DESCRIPTION	BASE RATE	STD-	STD+	SENS RNG	FACT SENS
CASE SCENARIO	EXPERT SYSTEMS					
C1F2	IT Infrastructure	0.805	0.650	0.959	0.308	0.691
C4F5	Transfer Agent	0.808	0.647	0.968	0.321	0.679
C4F3	Tech Champion	0.811	0.647	0.975	0.327	0.673
C1F5	IT Mechanisms	0.772	0.602	0.943	0.341	0.659
C1F6	IT Aproach	0.815	0.656	0.975	0.320	0.680
C6F3	Tech Attributes	0.816	0.663	0.966	0.305	0.695
C4F4	Decision Maker	0.783	0.641	0.945	0.303	0.697
C6F8	Depth / Dissem	0.757	0.585	0.928	0.343	0.657
C6F1	Solution Feasibility	0.775	0.613	0.937	0.324	0.676
C4F1	End User	0.845	0.703	0.987	0.284	0.716
C1F4	Info Access	0.896	0.466	0.845	0.378	0.622
C6F6	Target Environment	0.781	0.604	0.919	0.315	0.685
C3F1	Industry Trends	0.664	0.460	0.949	0.369	0.611
C6F7	Marketing	0.684	0.523	0.865	0.342	0.658
C2F3	Resources	0.788	0.627	0.949	0.322	0.678
C5F3	Corp Policy	0.708	0.538	0.881	0.344	0.656
C6F4	Tech Effectiveness	0.789	0.652	0.926	0.274	0.726
C4F2	Mgr / Supervisor	0.819	0.680	0.957	0.277	0.723
C2F4	Costs	0.672	0.492	0.851	0.359	0.641
C6F2	Technical Risk	0.724	0.562	0.897	0.346	0.654
C6F5	Transfer Proposal	0.669	0.489	0.838	0.339	0.661
C5F5	Staff Profile	0.733	0.566	0.901	0.335	0.665
C2F2	Research Plan	0.640	0.481	0.820	0.359	0.641
C1F3	Info Flow	0.694	0.511	0.877	0.366	0.634
C5F1	Corp Culture	0.760	0.568	0.932	0.344	0.656
C5F4	Org Environment	0.734	0.570	0.898	0.328	0.672
C2F1	Tech Lifecycle	0.726	0.538	0.914	0.377	0.623
C1F1	Org Structure	0.602	0.387	0.838	0.470	0.530
C5F2	Current Situation	0.679	0.507	0.861	0.344	0.656
C3F3	Economic	0.613	0.401	0.824	0.424	0.576
C3F2	Political	0.614	0.408	0.821	0.413	0.587
AVG	CATEGORIES					
C4	Human	0.815	0.664	0.966	0.302	0.698
C1	Communications	0.724	0.542	0.906	0.364	0.636
C6	Technology	0.748	0.586	0.910	0.323	0.677
C2	Financial	0.708	0.529	0.884	0.354	0.646
C5	Corporate	0.723	0.553	0.893	0.339	0.661
C3	External	0.627	0.423	0.831	0.408	0.592
TOT	OVERALL	0.733	0.582	0.904	0.343	0.657

SCENARIO DETAILS

FACT APPL	SUP / HIND	DEG	CONF	ACT RATE
1	1	1	1	1.007
1	1	0.882	0.9	0.987
1	1	0.85	0.85	0.979
1	1	0.9	0.9	0.967
1	1	0.78	0.94	0.965
1	1	0.8	0.7	0.938
1	1	0.8	0.75	0.922
1	1	0.775	0.813	0.916
1	1	0.611	0.733	0.883
1	1	0.25	0.717	0.880
1	1	0.9	0.9	0.879
1	1	0.713	0.7	0.876
1	1	0.85	0.9	0.876
1	1	0.8	0.84	0.862
1	1	0.38	0.72	0.856
1	1	0.65	0.85	0.854
1	1	0.562	0.6	0.851
1	1	0.033	0.767	0.830
1	1	0.8	0.7	0.826
1	1	0.329	0.714	0.792
1	1	0.7	0.675	0.790
1	1	0.38	0.6	0.786
1	1	0.5	0.8	0.758
1	1	0.325	0.625	0.752
1	-1	0.025	0.625	0.750
1	-1	0.25	0.7	0.697
1	1	0	0.4	0.684
1	-1	0.1	0.733	0.627
1	-1	0.22	0.48	0.611
1	-1	0.8	0.8	0.491
1	-1	0.9	0.3	0.369
5			0.787	0.920
6			0.833	0.866
8			0.722	0.864
4			0.666	0.781
5			0.651	0.740
3			0.667	0.578
31			0.730	0.815

MODEL DETAILS SORTED ON ACTUAL RATING

GRAPH # 1
SUCCESS POTENTIAL

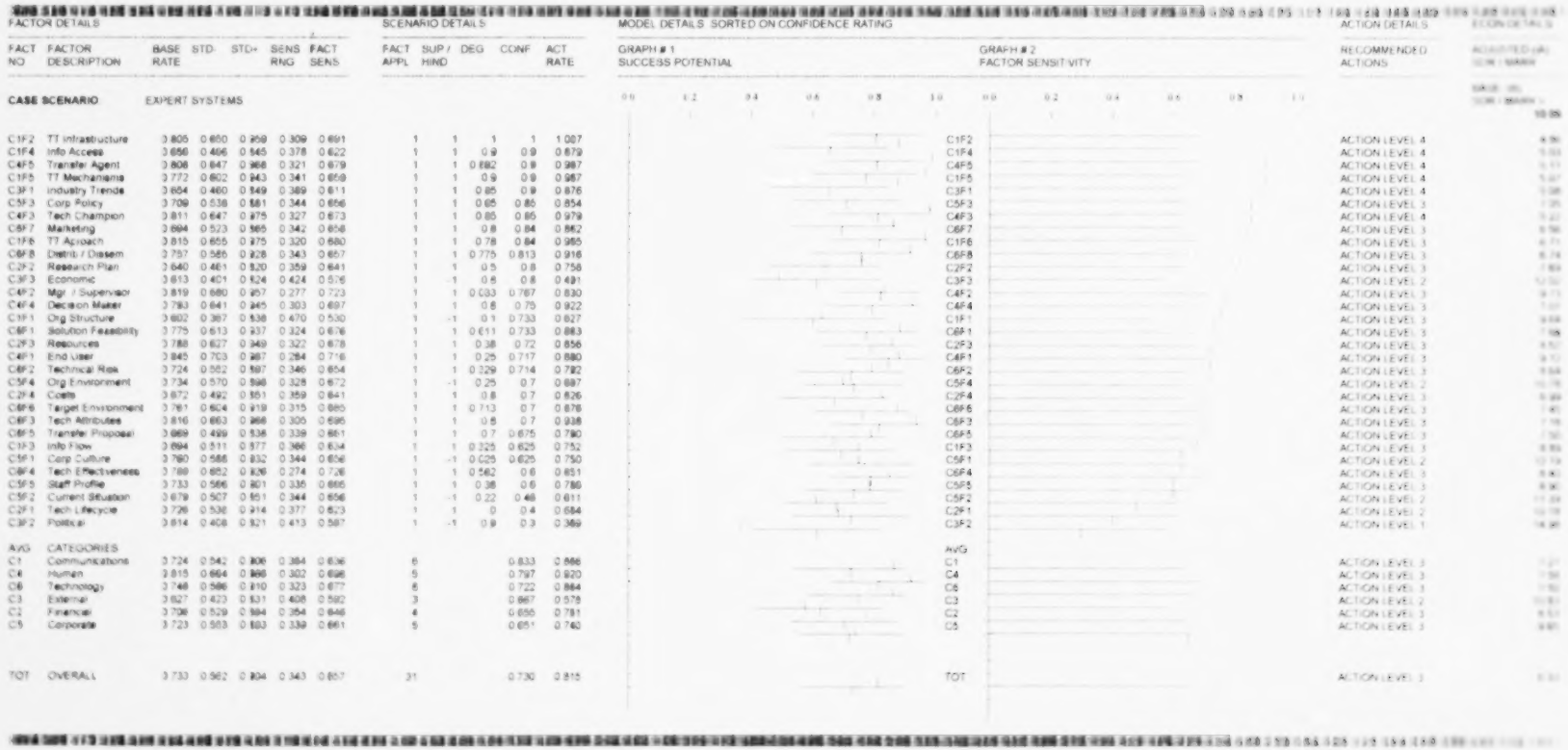
GRAPH # 2
FACTOR SENSITIVITY

C1F2
C4F5
C4F3
C1F5
C1F6
C6F3
C4F4
C6F8
C6F1
C4F1
C1F4
C6F6
C3F1
C6F7
C2F3
C5F3
C6F4
C4F2
C2F4
C6F2
C6F5
C5F5
C2F2
C1F3
C5F1
C5F4
C2F1
C1F1
C5F2
C3F3
C3F2
AVG
C4
C1
C6
C2
C5
C3
TOT

ACTION DETAILS

RECOMMENDED ACTIONS
ACTION LEVEL 4
ACTION LEVEL 4
ACTION LEVEL 4
ACTION LEVEL 4
ACTION LEVEL 3
ACTION LEVEL 3
ACTION LEVEL 3
ACTION LEVEL 3
ACTION LEVEL 3
ACTION LEVEL 4
ACTION LEVEL 3
ACTION LEVEL 4
ACTION LEVEL 3
ACTION LEVEL 3
ACTION LEVEL 3
ACTION LEVEL 3
ACTION LEVEL 3
ACTION LEVEL 3
ACTION LEVEL 3
ACTION LEVEL 3
ACTION LEVEL 3
ACTION LEVEL 2
ACTION LEVEL 2
ACTION LEVEL 2
ACTION LEVEL 3
ACTION LEVEL 2
ACTION LEVEL 2
ACTION LEVEL 1
ACTION LEVEL 3
ACTION LEVEL 3
ACTION LEVEL 3
ACTION LEVEL 3
ACTION LEVEL 3
ACTION LEVEL 2
ACTION LEVEL 3

FIGURE 11 CONFIDENCE RATE PERSPECTIVE



FACTOR DETAILS

FACT NO	FACTOR DESCRIPTION	BASE RATE	STD	STD+	SENS RNG	FACT SENS
CASE SCENARIO	EXPERT SYSTEMS					
C1F2	TT Infrastructure	0.805	0.650	0.959	0.309	0.691
C1F4	Info Access	0.656	0.406	0.845	0.378	0.622
C4F5	Transfer Agent	0.808	0.647	0.968	0.321	0.679
C1F5	TT Mechanisms	0.772	0.602	0.943	0.341	0.659
C3F1	Industry Trends	0.654	0.460	0.949	0.389	0.611
C5F3	Corp Policy	0.709	0.536	0.881	0.344	0.656
C4F3	Tech Champion	0.811	0.647	0.975	0.327	0.673
C6F7	Marketing	0.694	0.523	0.865	0.342	0.658
C1F6	TT Approach	0.815	0.655	0.975	0.320	0.680
C6F8	Distrib / Dissem	0.757	0.586	0.928	0.343	0.657
C2F2	Research Plan	0.640	0.461	0.820	0.359	0.641
C3F3	Economic	0.613	0.401	0.824	0.424	0.576
C4F2	Mgr / Supervisor	0.819	0.680	0.957	0.277	0.723
C4F4	Decision Maker	0.783	0.641	0.945	0.303	0.697
C1F1	Org Structure	0.602	0.387	0.538	0.470	0.530
C6F1	Solution Feasibility	0.775	0.613	0.937	0.324	0.676
C2F3	Resources	0.788	0.627	0.949	0.322	0.678
C4F1	End User	0.845	0.703	0.987	0.284	0.716
C6F2	Technical Risk	0.724	0.562	0.897	0.346	0.654
C5F4	Org Environment	0.734	0.570	0.998	0.328	0.672
C2F4	Costs	0.872	0.492	0.951	0.359	0.641
C6F6	Target Environment	0.761	0.604	0.919	0.315	0.685
C6F3	Tech Attributes	0.816	0.663	0.968	0.305	0.695
C6F5	Transfer Proposal	0.669	0.499	0.838	0.339	0.661
C1F3	Info Flow	0.694	0.511	0.877	0.366	0.634
C5F1	Corp Culture	0.760	0.586	0.932	0.344	0.656
C6F4	Tech Effectiveness	0.789	0.682	0.926	0.274	0.726
C5F5	Staff Profile	0.733	0.566	0.901	0.335	0.665
C5F2	Current Situation	0.679	0.507	0.851	0.344	0.656
C2F1	Tech Lifecycle	0.726	0.538	0.914	0.377	0.623
C3F2	Political	0.814	0.408	0.921	0.413	0.587
AVG	CATEGORIES					
C1	Communications	0.724	0.542	0.906	0.364	0.636
C4	Human	0.815	0.664	0.966	0.302	0.698
C6	Technology	0.748	0.586	0.910	0.323	0.677
C3	External	0.627	0.423	0.831	0.408	0.592
C2	Financial	0.709	0.529	0.984	0.354	0.646
C5	Corporate	0.723	0.583	0.883	0.339	0.661
TOT	OVERALL	0.733	0.562	0.904	0.343	0.657

SCENARIO DETAILS

FACT APPL	SUP / HIND	DEG	CONF	ACT RATE
1	1	1	1	1.007
1	1	0.9	0.9	0.879
1	1	0.882	0.9	0.987
1	1	0.9	0.9	0.987
1	1	0.85	0.9	0.876
1	1	0.85	0.85	0.854
1	1	0.85	0.85	0.979
1	1	0.8	0.84	0.862
1	1	0.78	0.84	0.965
1	1	0.775	0.813	0.916
1	1	0.5	0.8	0.758
1	1	0.6	0.8	0.491
1	1	0.033	0.787	0.830
1	1	0.6	0.75	0.922
1	-1	0.1	0.733	0.827
1	1	0.611	0.733	0.883
1	1	0.38	0.72	0.856
1	1	0.25	0.717	0.880
1	1	0.329	0.714	0.782
1	-1	0.25	0.7	0.697
1	1	0.8	0.7	0.826
1	1	0.713	0.7	0.878
1	1	0.6	0.7	0.938
1	1	0.7	0.675	0.780
1	1	0.325	0.625	0.752
1	-1	0.025	0.625	0.750
1	1	0.562	0.6	0.851
1	1	0.38	0.6	0.786
1	-1	0.22	0.46	0.611
1	1	0	0.4	0.684
1	-1	0.9	0.3	0.369
6			0.833	0.866
5			0.797	0.920
6			0.722	0.864
3			0.667	0.578
4			0.656	0.781
5			0.651	0.740
31			0.730	0.815

MODEL DETAILS SORTED ON CONFIDENCE RATING

GRAPH # 1
SUCCESS POTENTIAL

GRAPH # 2
FACTOR SENSITIVITY

ACTION DETAILS

RECOMMENDED ACTIONS
ACTION LEVEL 4
ACTION LEVEL 4
ACTION LEVEL 4
ACTION LEVEL 4
ACTION LEVEL 4
ACTION LEVEL 3
ACTION LEVEL 4
ACTION LEVEL 3
ACTION LEVEL 3
ACTION LEVEL 3
ACTION LEVEL 2
ACTION LEVEL 3
ACTION LEVEL 3
ACTION LEVEL 3
ACTION LEVEL 3
ACTION LEVEL 3
ACTION LEVEL 2
ACTION LEVEL 3
ACTION LEVEL 3
ACTION LEVEL 3
ACTION LEVEL 2
ACTION LEVEL 2
ACTION LEVEL 1
ACTION LEVEL 3
ACTION LEVEL 3
ACTION LEVEL 3
ACTION LEVEL 2
ACTION LEVEL 3
ACTION LEVEL 3
ACTION LEVEL 3